EXAMINING LOW-COST SIMULATION AND SITUATIONAL AWARENESS ASSESSMENT IN ARMY AVIATION APPLICATIONS

by

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ABSTRACT

The concept of using simulation for training is not new in the aviation experience. Flight simulators have been in existence since the early 1920s and have evolved from non-mechanical, tethered aircraft to high fidelity, multi-million dollar motion platforms. In the demanding and dynamic environment of aviation, errors can be catastrophic. It is not surprising that both the civilian and military communities have made simulation training a critical component of their aviation training programs.

Despite the wide variety of simulation training efforts being pursued by military and civilian aviation alike, there is limited research on the subject of low-cost team training, particularly in the area of situation awareness. Most research has been directed toward individual task performance. Only in recent years has additional emphasis been placed on crew resource management (CRM). Even less literature exists on the concept of aircraft to aircraft team training – an *inter*cockpit training model as opposed to an *intra*cockpit training model. Simulation being used by the U.S. Army that is team based focuses mostly on commander and battle staff training.

There is a clear lack of research concerning the suitability of using low-cost simulation for training U.S. Army aviators in team collective tasks and situational awareness (SA). The purpose of this research is to develop an assessment tool and conceptual model, tailored to emulate Army aviation platforms, that can be used in

assessing the suitability of this approach for achieving Army aviation team collective task and situational awareness training goals. Lessons learned and areas for future research are also discussed.

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While the members of my thesis committee assisted me tremendously, I would be remiss not to recognize those closest to my heart. My mother and Bob provided tremendous emotional support during times of great academic stress and deadlines. J. P. Carrithers, Ray Cech, and Mike Dolezal took the time ensure that my operational theories and products were sound. Finally, I want to express my deepest appreciation to my fiancé, Christof, who provided the support, advice, and flexibility needed to concentrate and prioritize my efforts. Your love and patience were instrumental in this research project's completion. To all these people, I owe my sincere thanks and gratitude.

"In 1901, my father had a dream of building an aircraft that could take-off and land vertically. In 1931, he patented a design of a now familiar helicopter layout – a single large main rotor and a small anti-torque tail rotor. In the summer of 1939, he began in earnest to develop the world's first successful, practical helicopter.

This steel tube and open cockpit vehicle, that he called the VS 300, flew under tethered flight with my father at the controls for only a few minutes. Within a year, the experimental helicopter would remain airborne for longer periods of time.

When asked how he succeeded in making a helicopter work when so many others had failed, he said, 'I do not know. Maybe it was just because nobody told me that it couldn't be done!'"

- Igor Sikorsky, Jr.

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CHAPTER 1

INTRODUCTION

1.1 Background

A common credo used in the U.S. Army professes "as you train, so shall you fight". Training the force to win on the battlefield is critical to ensuring the coordinated and accurate execution of doctrine in the fluid and ever-changing environment of modern warfare. Lack of training results in errors that will, undoubtedly, have consequences on the battlefield. In the dynamic environment of aviation, these consequences can have disastrous and even fatal results. For this reason, it is not surprising that both the civilian and military communities have incorporated, and relied heavily upon, simulation as a critical component of their aviation training programs. Advancements in technology have greatly enhanced this ability. Today it is possible to replicate virtually any environment or element of equipment for use in training simulation. Still, as training budgets continue to become smaller and smaller, the need to find low-cost alternatives for training has become imperative.

Most training research efforts in aviation, particularly from World War II to the present, have focused on the use of simulation to enhance pilot training. The concept of using simulation for training is not new in the aviation experience. Flight simulators

have evolved from non-mechanical, tethered aircraft of the 1920s, to high fidelity, multi-million dollar motion platforms with six degrees of freedom (*df*). A majority of this research has been directed toward individual task performance and psychomotor skills. However, in light of the many military and commercial airline accidents that have occurred due to crew error, the emphasis in recent years has shifted towards team training in the cockpit, otherwise known as crew resource management (CRM). Although there is much literature concerning the subjects of aircrew training, team processes, and team training in general, little research has been done to extend these concepts for aircraft to aircraft applications, thus developing an *intra*cockpit training model as opposed to an *inter*cockpit training model.

Even less literature exists concerning the suitability of using low cost simulation to train team processes, such as situational awareness (SA), and behaviors between aircraft, specifically in U.S. Army aviation (personal communication with Mr. Delashaw, May 28, 1999). There have been aviation-related studies conducted in other services that explore comparisons between individual and team knowledge structures and team performance in multi-service distributed training exercises (Gualtieri, Fowlkes, & Ricci, 1996; Oser, Dwyer, & Fowlkes, 1995). Although the cognitive processes studied were very applicable in terms of aviation team training, they were conducted using medium to high fidelity, geographically remote simulators and focused more on crew behaviors rather than the value of intercockpit training.

1.2 Current Army Aviation Training Practices

To ensure that army aviators maintain proficiency in flying skills and applied operations, the army requires that pilots pass an annual proficiency and readiness test (APART). This test consists of a series of written and flight evaluations, in which the aviator must demonstrate an acceptable level of aircraft knowledge, flying skills, and aviation related subjects (DA, 1992). The instrument flight evaluation can be performed in a flight simulator if available. The tasks that each aviator must perform are outlined in great detail, with their associated descriptions of task, condition, and standards, in each aircraft's specific Aircrew Training Manual (ATM) (DA, in press). Pilots are also required to complete a minimum number of iterations of certain tasks in a semi-annual and annual period. Despite this emphasis, there is very little focus or specificity given to team or inter cockpit training.

Chapter 6 of the ATM does specifically address crew coordination, but the subject matter primarily focuses on those elements that make an effective crew *within* the cockpit as opposed to between aircraft. Crews frequently use simulators to reinforce CRM concepts, but these scenarios represent only single ship operations. This lack of emphasis is evident in the non-specific, and often vague, references to any task involving multiple aircraft operations. In the UH-60 Blackhawk helicopter ATM, for example, there is only one task, labeled "Perform multi-aircraft operations" (in press), that addresses multiple aircraft interaction in terms of a required annual task. Due to the complex nature of determining how a flight of aircraft and the individual pilots within it have "met the

standard", the task guidance basically bequeaths the conduct of the task and what is to be performed to the discretion of the instructor pilot(s). The evaluation of this task requires the use of two aircraft or more. Over time, this can prove to be a costly endeavor. PC-based simulation is seldom used as a rehearsal tool, however, aviators do use PCs for various functions of mission planning, e.g. weather, performance planning, etc.

1.3 Simulation and PC-Based Training

PC-based simulation already exists in many forms in the gaming community and has been used to investigate team processes (Stout, Salas, & Carson, 1994). Additionally, they have been integrated into the initial phases of general aviation in the form of interactive courseware and instrument training devices. However, bringing PC-based training simulation into aviation team training alone will not define its applicable benefits for aviation team training use.

As indicated in previous discussions concerning annual aircrew training, U.S. Army aviation currently has little in the way of PC-based aviation team training. Though simulation is used extensively in army aviation training, these efforts focus primarily on aircraft qualification training, CRM, battle staff training, and the linkage of high cost systems to other army simulation centers for the purpose of conducting combined arms exercises. There has been minimal emphasis placed on using PC-based simulation to link aircraft together for training team SA, and team processes in multi-ship helicopter operations (personal communication with Mr. Delashaw, May 28, 1999).

There is no doubt that simulation is prevalent in almost every facet of the Army – from simulation based acquisition to training, and it is most certainly at the forefront of army aviation training (DA, in press). Still, focus on PC-based simulation training is relatively limited, and what simulation that is available is extremely high fidelity and definitely high cost (Fort Rucker, 1999). Training the force is, unquestionably, an integral part of the Army's readiness, yet this priority is primarily served by very large-

scale distributed training simulation exercises connecting geographically separated military facilities.

1.4 Current Army Aviation Simulation Efforts

Most efforts to upgrade aviation training and its interaction with other Army battlefield operating systems occur at the U.S. Army Aviation Center, located at Fort Rucker, Alabama. One individual who has been close to these developments is Mr. Jim Delashaw, a representative of the Program Executive Office for Aviation (PEO Avn) who interfaces with the Directorate for Training, Doctrine, and Simulation (DOTDS) at Fort Rucker. According to Mr. Delashaw, there is an ongoing project at the Aviation Test Bed (AVTB) that involves configuring PC-based systems to run synthetic battlefield entities and terrain and also run image generators that can show these entities to the crew. These type of systems are referred to as Fully Reconfigurable Engineering Devices (FREDs), which were originally developed for the Simulation Net (SIMNET) program, and still represent the primary training system used for team and unit training (personal communication with Mr. Delashaw, May 28, 1999).

Another team training simulation system currently in development is the Aviation Combined Arms Tactical Trainer (AVCATT). When fully developed, this particular training device will link with other elements of a larger Combined Arms Tactical Trainer (CATT) community that includes similar engineer, air defense, and fire support trainers (STRICOM, 1999). This system, however, is definitely high cost, and at least moderate in its fidelity.

The only low-cost simulation training device that has been developed for Army aviation team training is the Aviation Reconfigurable Manned Simulator (ARMS)

(STRICOM, 1999). It is intended to be fielded to the Army National Guard (ARNG) in December 1999 and does focus on training aviation collective tasks. However, it is not PC-based, and there is little evidence at this time to suggest whether aircraft-to-aircraft team training is emphasized.

Though the use of simulation for aviation training exists in many forms in the military community, the literature suggest that the development of low-cost simulation for Army aviation team training is limited. However, simply introducing a platform, such as a PC-based system, into the picture is not sufficient for validating its training effectiveness. An understanding of how teams share knowledge and how tasks are analyzed is also critical to ensuring the development of a successful training device. This realization begs several questions: 1) Can current models for team training be extended for intercockpit team training or is the formulation of a new model required?, 2) What tasks and behaviors are necessary to achieve team SA in Army helicopter pilots?, and 3) Is low-cost, PC-based simulation a valid tool for training these behaviors?

CHAPTER 2

TEAM TRAINING, SITUATION AWARENESS, AND FIDELITY

2.1 Teams and Teamwork Defined

Before launching into a detailed discussion of team training and its functions in aviation training, it is necessary to have a clear understanding of what a team is. In a variety of sources, the definition of team training has taken on many forms. However, the definition put forth by Salas, Dickinson, Converse, and Tannenbaum (1992) is one that is generally accepted, and can be best applied, in the operational and academic communities. They define a team as "a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have limited life span and membership" (p. 4). It is important to note that teams are distinguishable from groups in that groups may be required to interact, but do not necessarily need to coordinate actions for mission accomplishment (Salas & Cannon-Bowers, in press).

A tactical decision-making team such as a tank platoon or a flight of helicopters often has other characteristics that can have a dramatic effect on the level of SA and, ultimately performance, that the team can achieve. The operational tactical teams of today follow a hierarchical structure and must constantly adjust to rapid changes in the

environment (Orasanu & Salas, 1993). In the case of military helicopter operations, this normally involves responding to extremely high cockpit workloads, adverse weather conditions, time constraints, mission changes, and the threat of enemy engagement.

In the field of aviation, we tend to associate team training with crew coordination or CRM (see Baker & Salas, 1992; Orasanu & Salas, 1993; Prince & Salas, 1999; Stout, Salas, & Carson, 1994). However, these ideas can be extended to include multi-ship operations in which multiple crews operate in separate aircraft, but towards the same objectives – mission accomplishment and personnel safety. This type of training would focus primarily on an *inter*cockpit training environment/model as opposed to an *intra*cockpit one. In this case the team behaviors, such as communication and decision-making, can be projected beyond the cockpit to incorporate factors associated with not being able to see other members of the team due to aircraft separation.

From our definition of a team, we can derive a similar definition of teamwork. Stout *et al.* (1996) summarize teamwork "as an identifiable set of behaviors, cognitions, and attitudes that contribute to the team's overall functioning" (p. 89). Although a great deal of empirical studies have focused on teamwork and team behaviors, there has not been much attention given to how the components of teamwork and their corresponding interactive processes affect decision-making and SA (1996). The proper implementation of shared mental models and cognitive task analysis play important roles and may contribute to the training and evaluation of these components.

2.2 Shared Mental Models

Key to maximizing the training and evaluation of team behaviors and processes is an understanding of how mental models contribute to the overall learning process. By combining the descriptions of various experts (Orasanu, 1990; Cannon-Bowers, Salas, & Converse, 1993) we can define a mental model as a psychological or mental representation of specific components of knowledge that exist within a particular environment. A mental model may also represent the relationships between various elements of knowledge (Klemoski & Mohammed, 1994). Likewise, "shared" mental models are mental models that team members hold in common. For our purposes we will focus on the use of shared mental models in developing team SA. The concept of team SA will be discussed in greater detail in a later section concerning SA.

In an effort to fill the gap in team training, shared mental models have been brought to the forefront of team training studies. It is clear that these models are necessary because they enable team members to effectively handle situational change and predict needs and actions of other team members (Stout, *et al.*, 1996). To assist in determining how shared mental models contribute to the team training process, we must ask ourselves what type of knowledge team members need to share in order to complete their tasks (1996). Team member goals, attitudes, roles, and tasks all contribute towards effective task accomplishment (Canon-Bowers, Salas, & Converse, 1993). Converse and Kahler (1992) have suggested that there are three forms of knowledge that team members can hold in common: declarative, procedural, and strategic.

Declarative, or factual, knowledge concerns the rules and facts that govern a situation, to include equipment, system components, team members, and their relationships (Stout, Cannon-Bowers, & Salas, 1994). Procedural knowledge is more of a sequential form of knowledge in which there is an understanding of task relationships and how the actions of other team members affect these relationships (1994). Stout, *et al.* (1996) point out that it is important that certain portions of declarative and procedural knowledge must be shared among team members:

> ...[I]t is probably not necessary for team members to share an understanding of detailed information regarding each other's equipment. However, one could speculate that team members should understand: 1) what important information a fellow team member needs from them in order for him/her to accomplish his/her tasks and 2) when in a task sequence this information should be presented. (p. 90)

In an aviation context, we can demonstrate this point with an example of a tandem cockpit configuration, such as that of an AH-64 Apache helicopter, in which the pilot and the copilot/gunner cannot see each other's displays or cockpit environment. Neither needs to know every detail of what is going on in each other's environment, but each needs to have knowledge of, and be aware of, each other's functions so as to assist or "cover" each other as the tactical situation evolves.

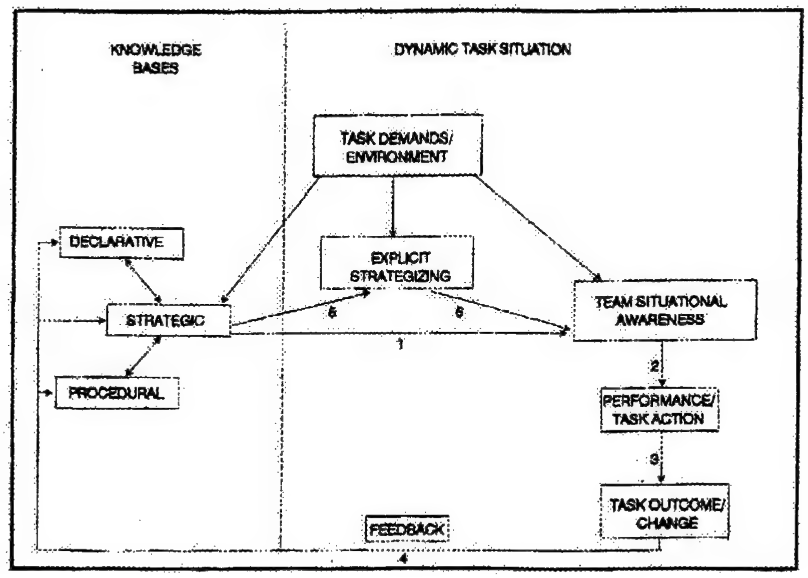
Strategic knowledge, according to Converse and Kahler (1992), serves as the basis for problem solving. It includes such information as "knowledge of the context in which procedures should be implemented, actions to be taken if a proposed solution fails,

and how to respond if necessary information is absent" (p. 6). Subsequently, it follows that team performance will only be effective when there is shared strategic knowledge among team members (Stout, *et al.*, 1996). Another important consideration deals with the fact that declarative and procedural knowledge remain static while strategic knowledge changes based upon task parameters and team member responses to task events and environmental demands (Stout, *et al.*, 1994). In order to avoid future confusion between the cognitive definition of "strategic" and the military definition, we will further refer to strategic knowledge as "operational knowledge".

Figure 1, extracted from Stout, *et al.*, (p. 98, 1996) shows how shared mental models can be incorporated in, and transformed into, SA. This graphic model basically depicts three specific situations with respect to shared mental models and teams: 1) those that severely limit or exclude explicit strategizing, 2) those that allow for only minimal and efficient explicit strategizing, and 3) those that allow for unlimited explicit strategizing. The term explicit strategizing specifically refers to behaviors or processes that team members participate in for the purposes of disseminating information, clarifying actions and procedures, and planning for future activities (Stout, *et al.*, 1996). In the case of CRM and intercockpit interaction, this is best communicated with verbal communication.

The flow of the figure shows how teams draw from shared knowledge bases to arrive at a certain level of SA. Shared operational knowledge allows for constant validation and reassessment to take place. Feedback from previous events provides for the adaptation and updating of existing team models. Eventually, team members will be

able to coordinate actions implicitly as opposed to explicitly. This will have a significant impact on the ability of multiple aircraft crews to communicate effectively and efficiently, and enhance SA.



<u>Figure 1.</u> A graphical representation of shared mental models (Stout, Cannon-Bowers, &Salas, 1996)

2.3 Situation Awareness Defined

In the conduct of aviation operations, the ability of pilots to function in three-dimensional space, process events occurring "beyond the cockpit", and react quickly and appropriately to unanticipated mission changes is imperative. Within the complex system environment, research has suggested that a hypothetical construct, which is referred to as "situation awareness" (SA), can be used to represent a pilot's, or any system operator's, knowledge of the current situation relative to the desired result (Bowers, Braun, & Kline, 1994). Consequently, the lack of SA and/or the failure to maintain it has been referenced as a major contributing factor in mishaps involving complex systems, such as aircraft, and can have catastrophic repercussions (Endsley, 1988). One analysis of military aircraft accidents that were caused by human error indicated that lack of, or problems with, SA on the part of critical crewmembers contributed to these mishaps (Härtel, Smith, & Prince, 1991).

Despite the fact that the need to focus on SA has been recognized, there has not been substantial attention paid to team SA. The preponderance of research efforts has placed emphasis on individual task performance and SA. Many believe that this may be due to the lack of definition clarity discussed earlier (Stout, *et al.*, 1992) and that it is customary to investigate the performance of individual team members in a team setting as opposed to examining team-level behavioral changes resulting from training (1992). Even less emphasis has been placed on investigating team SA in an aircraft-to-aircraft environment.

In order to discuss how SA contributes to overall aviation performance, it is necessary to have a clear definition of exactly what SA is. In many areas of research, this has been particularly difficult to obtain. SA has a notorious reputation as a fairly loose term, for how does one determine if an individual, or team for that matter, is truly "situationally aware"? To arrive at an appropriate definition, we must define what is meant by a "situation". Pew (1994) defines a situation as "a set of environmental conditions and system states with which the participant is interacting that can be characterized uniquely by a set of information, knowledge, and response options" (p.18, Table 1). Pew goes on to describe the associated elements of a situation which subsequently constitute "awareness". The table below, extracted from Pew, provides a synopsis of these elements. Parenthetical descriptions indicate how these elements would apply to a team.

- Current state of the system (includes equipment, people, etc.)
- Predicted state in the future
- Information and knowledge required to support crew activities
- Activity phase (involving crew/team)
- Prioritized list of goals (overall team objectives)

<u>Table 1.</u> Elements of Awareness

By combining these uses of SA, we can apply them toward understanding a more formal, and traditionally accepted, definition put forth by Endsley (1988, 1995). He defines SA as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (1995, p. 31). In expanding on this concept, Endsley (1995) describes the construct of SA in three hierarchical phases, which are shown in Table 2:

♦ Level 1 SA – Perception of environmental elements
♦ Level 2 SA – Current situation comprehension
♦ Level 3 SA – Projection of future status

Table 2. Levels of Situation Awareness

Level 1 SA is achieved by perceiving, or being provided specific data for the status, attributes, and dynamics of relevant elements in the environment (Endsley, 1995). In the case of a military aviator, the perception of terrain, other aircraft, enemy locations and capabilities, own aircraft status, and warning lights would be required. Additionally, the aviator must also be able to perceive relevant characteristics of each of these elements such as color, quantity of enemy troops or equipment, speed, etc.

Achieving Level 2 SA "is based on a synthesis of disjointed Level 1 elements" (Endsley, 1995, p. 31). This implies transcending the state of basic awareness of present elements. In Level 2 SA, knowledge of Level 1 elements are combined to form patterns that enable a decision-maker to comprehend the significance of elements and events

(1995). For example, a military pilot must be able to comprehend how the position, type, number, and proximity of enemy equipment, such as tanks or helicopters, betrays or indicates specifics about their intentions. It is important to note that a novice pilot may be able to achieve the same or a superior degree of Level 1 SA as a very experienced pilot, yet be incapable of integrating situation elements in order to achieve comprehension. Recognition of this fact is essential when examining the results of studies or experimentation involving SA.

Level 3 SA is concerned with "the ability to project the future actions of the elements in the environment, at least in the near term" (1995, p. 32). This level can only be achieved through the acquisition of Level 1 and 2 SA. Future projection allows a decision-maker to choose a course of action that will most likely contribute to mission accomplishment. If a military pilot knows that a pair of threat aircraft is in a particular flight configuration and in a certain location, the pilot can project in what manner the aircraft are likely to attack (1995).

Beyond recognizing the three levels of SA, we must also consider other aspects of SA. One of these aspects concerns the temporal nature of SA. It is often built up over time and not acquired instantaneously (1995). Additionally, SA can be very spatial in nature. According to Endsley (1995), spatially determined aspects of a situation involve the specification and selection of which environmental aspects are important. He describes this concept as a series of fluid boundaries that are constantly changing:

> Situation awareness can be conceived of as concerning the subset of the environment which is considered relevant to the task(s) at hand. This

boundary can be seen to shrink or expand as various tasks present themselves.... (p. 32).

Figure 2, extracted from Endsley (1995), depicts these boundaries as they may apply to a fighter pilot.

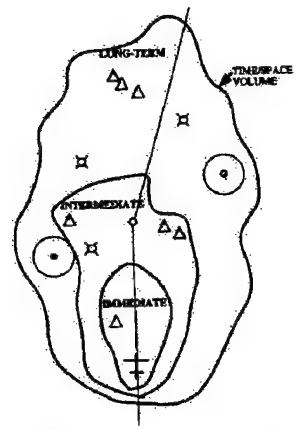
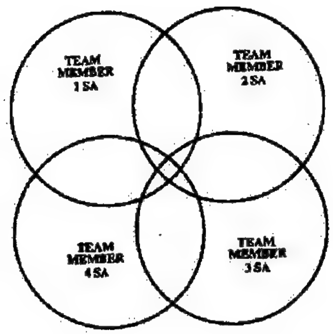


Figure 2. Fighter Pilot SA

In the context of this discussion, it is also necessary to address SA as it applies to team concepts. Working together demands a reliance on team member SA in order to effectively coordinate actions and resources (Muñiz, Stout, & Salas, 1996). Complex environments, such as those involving aviation operations, inevitably require multiple individuals, or crews, to make decisions and perform tasks. One can conceive of *overall team SA* as a situation in which "each team member will have a specific set of SA elements about which they are concerned, as determined by their responsibilities within the team" (1995, p. 33). This implies a certain degree of SA overlap between team members, as depicted by Endsley (1995) in Figure 3. This overlap can also be described

as shared information that serves as "an index of inter-team coordination and human-machine interface effectiveness" (p.34).



<u>Figure 3.</u> Team SA Overlap.

2.4 Communication and Team Situation Awareness

There has been substantial research in recent years examining how various factors affect SA. Many have suggested that attaining team SA is highly dependent upon communication (Palmer, 1990; Salas, Prince, Baker, & Shrestha, 1995). One study conducted by Mosier and Chidester (1991) investigated how solicitation and transfer communication served as indicators of SA during simulated in-flight emergencies and other activities. In this study, verbal communication was used as an index of team SA. After analyzing the communications of 23 three-person crews, results showed that the level of team SA affected overall performance.

The relationship between communication and team SA may have a foundation in the construct of shared mental models, a concept discussed earlier. Salas et al. (1995) suggested that in order for team members to formulate relevant expectations of the overall mission/global task, each team member must possess and relay information that contributes to this process. Developing these expectations can be achieved by sharing pre-existing knowledge bases and by communicating task-relevant information. Additionally, mental models and strategies can be updated and modified as team members collect and relay new information about the task (Orasanu, 1990).

Cannon-Bowers et al. (1993) indicated that the degree to which team members share mental models clearly affects task completion. Specific examples include a team's a) coordination of activities, b) adaptation to dynamic task and team demands, c) projection of team and task needs, and d) prioritization of when to exchange pertinent

information. A recent study conducted by Muñiz, et al. (1996) examined the relationship between communication, shared mental models, and SA. Verbal responses across three specified aspects of an aviation scenario (reaction to other aircraft, air traffic control, and weather) were used to measure each team's communication process. Results showed that teams with no shared mental models "used significantly more communication related to general/less relevant information during high workload…than teams with shared mental models" (p. 11). Additionally, Muñiz et al. (1996) discovered that as workload increased, both groups increased their overall communication and modified their communication processes.

2.5 Team Task Analysis and Performance Measurement

As implied in previous discussions, a proper understanding of what kind of knowledge is being trained is key to conducting an appropriate task analysis. Task analysis approaches, in general, have been recognized as being critical to the training design process, yet, once again, there has been little emphasis placed on training at the team level. Unfortunately, this has often resulted in the forced training of individual tasks within a team environment (Salas & Cannon-Bowers, in press). However, it is evident today that individual training is not equivalent to team training, and there is a definite need for a team task analysis tool. That is to say "the team task analysis (or collective task analysis) generates key information needed for designing and delivering team training" (Seamster, Rhedding, & Kaempf, 1997, p. 25).

In the case of aviation team training, it is generally accepted that the specific type of knowledge to be trained is primarily operational. At this point, through an analysis of present training guidance and subject matter expert (SME) consultation, it is possible to delineate and break down certain behaviors that can be categorized under certain levels of SA. The types of tasks chosen will depend upon the type of aircraft being flown, the type of mission to be accomplished, and the geography of the operational scenario (i.e., what theater of operations are we attempting to simulate). After determining these tasks, the next critical phase in training development and evaluation is the selection of performance measures.

One approach to addressing team performance measurement, as well as other components of teamwork, that has been extremely effective in recent studies is the Targeted Acceptable Response to Generated Events or Tasks, or TARGETs, methodology (Fowlkes, Lane, Salas, Franz, & Oser, 1994). This particular approach makes use of a checklist format that collects structured observations of team behaviors as they occur during operationally relevant scenarios. The key to this method is the identification of tasks that act as indicators of specific team behaviors that are being trained or observed (Oser, Dwyer, and Fowlkes, 1995). The tasks and behaviors elicited from these tasks are placed into a TARGETs checklist. Items in this list are compared to the behaviors of the subjects and are marked as either present or not present (1995). An example of such a checklist is illustrated in Figure 4 (Fowlkes, Lane, Salas, Franz, & Oser, 1994, p. 52).

EVENT	TARGET	CRITICAL AIRCREW COORDINATION BEHAVIOR
Section Leader asks crew to perform unsafe navigation procedure during preflight brief	Pilots question unsafe navigation procedure	State opinions on decisions/procedures (under Assertiveness)
Ship's helicopter direction center provides erroneous vector to first waypoint	Pilots question heading information	Ask question when uncertain (under Assertiveness)
Communications from ships tower, aircrewmen, lead aircraft	Pilots acknowledge communications	Acknowledge communication (under Communication)
En route navigation	Pilot-not-flying provides heading and distance for next leg of flight before waypoint is reached	Provide information in advance (under SA)
Section leader goes off course	Pilot-flying calls code word for "check navigation"	Note deviations (under SA)
Section leader calls for lead change	Pilot-flying uses standard terminology during lead change Pilot	Acknowledge communication (under Communication)

<u>Figure 4.</u> Examples of events, TARGETs, and associated critical crew behaviors for a dual piloted, military cargo helicopter.

There are positive aspects to using this methodology. One advantage lies in the fact that it is event-based (Fowlkes, Dwyer, Oser, & Salas, 1998). This implies that in a particular operational scenario stimulus events serve as cues for team members. These cues are designed to elicit certain behaviors that have been determined to be important through task analysis and SME consultation (1994). This practically removes the necessity to have SMEs as observers for training or experimentation, since behaviors specified on the TARGETs checklist are either present or they're not. Another advantage of this methodology is that it provides for flexibility in what is tested. Since the number of behaviors listed in a series of TARGETS checklists has no limitations, it is possible to investigate many general or a few specific components of team behavior. This method may be useful in evaluating elicited behaviors that suggest a level of SA.

In addition to this procedure, there are several other potential methods and techniques available for evaluating SA under experimental conditions. The catch lies in determining the best and, hopefully, least intrusive method to use when examining team training concepts. The ideal method would involve getting into an operator's mind and being able to observe exactly what the operator thinks and perceives at all times. Since this is not realistic, we must make use of other available measuring tools.

One such category of techniques uses physiological measures, such as an electroencephalogram (EEG), to determine whether information is being registered cognitively (Endsley, 1993). Though these techniques can allow observers to determine if elements in the environment are being perceived, they do not allow for the "determination of how much information remains in memory, if the information is

registered correctly in the mind, or what comprehension the subject has of those elements" (p. 81). For these reasons, current physiological techniques are not very useful in measuring SA. However, it should be noted that advancements in this arena could contribute significantly to our understanding and evaluation of SA.

Another potential tool for SA measurement involves the use of objective performance measures. They can be useful because they are objective and generally non-intrusive (1993). The collection of data is relatively simple, and system simulation components can be programmed to record specific performance data automatically. They exist in many forms such as global and external; however, these measures are limited because they either mask critical information concerning why poor performance occurs (global) or can actually detract from accurately assessing SA because of artificial alterations of the scenario (external) (1993). These factors make the use of performance measures a potentially ineffective method for evaluating SA.

Subjective techniques can also be used to assess SA. These techniques enable the operator to subjectively rate their own SA through a series of rigorous self and system evaluations. The operator (self-rating), the observer, or both can complete these ratings. One such self-rating method is the Situation Awareness Rating Technique (SART). This method allows for operators to rate a particular system "on the amount of demand on attentional resources, supply of attentional resources, and understanding of the situation provided. As such, it considers operators' perceived workload…in addition to their perceived understanding of the situation" (p.83).

A newer, more complex method known as the Subjective Workload Dominance (SWORD) metric requires operators or subjects to make "pairwise comparative ratings of competing design concepts" (p. 83) through the use of a numerical scale. This continuum indicates the degree to which a particular concept requires less workload than another. By incorporating these "preferences" into an analytic hierarchy process (AHP), evaluators can determine a numerically objective ordering of design and/or training concepts (1993).

One other method for SA measurement deals with the use of questionnaires. This technique serves as a more direct form of SA measurement since it directs operators to answer specific questions pertaining to SA indicators within the scenario. They may be given in a "post-test" fashion, which is fairly non-intrusive, or during a simulation as it is being run (freeze technique) (1993). The Situation Awareness Global Assessment Technique (SAGAT) is a freeze technique which interrupts the course of a simulation in order for the subjects to complete survey questions relative to the present state of the scenario. Because this technique is global, it includes queries that address all three levels of SA (1993). However, this technique is disadvantaged in that the freezing of the simulation may be intrusive or performance altering in some way, especially for certain military and flight operations.

2.6 Simulation and Fidelity

In the development of a training device and, subsequently, a training system, it is imperative to determine what level of fidelity is needed in order to accomplish the specified training goals. In addition to analyzing the tasks and objectives to be trained, we need to address the inclusion of an adequate level of fidelity in which cost effectiveness, cognitive engineering, and team performance measurement come together to provide a maximum learning benefit. As far as fidelity is concerned, more may not necessarily be better. Salas, Bowers, and Rhodenizer (1998) make this emphatically clear in stating that the "best simulation in the world does not guarantee training" and that "in the quest for a more realistic simulation, we may have lost sight of the true goal – a more effective training device" (p. 200).

As discussed earlier, PC-based simulation alone will not a great training device make. Salas, *et al.* (1998) point out that simulation is a vital part of aviation training that is capable of replicating detailed terrain features, in flight emergencies, weather phenomena, equipment, and an assortment of other conditions. Yet, they go on to discuss that in order to truly promote learning "there will need to be a shift in focus from the design of simulation for realism … to the design of human-centered training systems that support the acquisition of complex skills" (p. 199).

In order to determine the appropriate level of fidelity that should be used in the PC-based aviation team training realm, we should provide a clear working definition of what fidelity means and of what it is comprised. The concept of fidelity has carried a

rather fluid definition throughout the academic community, but as Hays and Singer (1989) relate, it "has most often referred to the design of simulation that is used in training" (p. 47). The tendency is to use one definition to cover all aspects and variables associated with the development of a particular training device or system. For the purposes of this research, the following definition of simulation fidelity given by Hays and Singer (1989) will be used in the discussion of fidelity applications:

> *Simulation fidelity* is the degree of similarity between the training situation and the operational situation which is being simulated. It is a two-dimensional measurement of this similarity in terms of: 1) the physical characteristics, for example, visual, spatial, kinesthetic, etc.; and 2) the functional characteristics, for example, the informational and stimulus response options for the training situation. (p. 50)

Of particular note is the clear distinction between the dimensions of physical and functional fidelity. From this definition, we can conclude that the level of fidelity needed is completely dependent upon what we intend to train. As Hays and Singer (1989) point out, departing from a high level of fidelity may not necessarily detract from the training effectiveness of a simulator, and because "higher fidelity is associated with higher costs, it is prudent to determine just how much fidelity is necessary in a training situation" (p. 52).

When considering aviation tasks, the spectrum of simulation fidelity can be broad. If the focus of the simulation is concerned with training individual or procedural tasks, such as emergency procedures, flight tasks, switchology, aircraft dynamics, or aircraft

qualification, then the physical fidelity of the simulation environment would need to be very high. In these instances, the emphasis is placed on enhancing psychomotor skills and muscle memory. Therefore, there exists a greater need to replicate the actual aircraft environment. However, when considering team training, the focus rests not so much on psychomotor skills as team behavior and cognitive responses to stimuli. In this case we are more concerned with a high level of functional fidelity and the simulator's ability to provide the appropriate inputs in order for the trainees to elicit a particular response.

It is safe to say that neither extreme is truly sufficient for quality training. An appropriate balance of each dimension of fidelity is necessary in order to train adequately the given tasks at hand. Hays and Singer (1989) confirm this point in stating that "situations for any task will require some degree of physical and functional fidelity, but the combination will vary depending on the physical and functional requirements of the operation" (p. 310).

The additional complexity of helicopter flight and its environment adds to this need for balance. Fixed wing aircraft generally require inputs from power controls, a control yoke (used for turning the aircraft left or right and for increasing and decreasing the pitch, or nose angle, of the aircraft) and pedals (used primarily for steering control during ground operations, and for coordinated turning in air operations). Power settings can be set for a specified level and the aircraft can basically be "trimmed" to require only minimal control yoke inputs during most modes of flight. Rotary wing aircraft require continual control inputs from a cyclic (left, right, pitch up, pitch down), collective

(power), and pedals. Any movement of one of the controls requires a corresponding movement in the other two.

In order for PC-based simulation to be effective for team training in a helicopter environment, it must contain enough physical fidelity to adequately represent the mental demands and flight responses to be encountered, yet still provide enough stimuli to elicit responses to team training objectives. There has been a significant amount of research done in recent years to investigate PC-based aviation training devices (PCATDs). Many of these studies have focused on the use of PC-based simulation to observe performance in the area of crew coordination and CRM (Koonce & Bramble, 1998; Jentsch, Bowers, & Holmes, 1995; Jentsch & Bowers, 1998; Stout, Salas, & Merket, 1998; Bowers, Salas, Prince, & Brannick, 1992; Baker, Prince, Shrestha, Oser, and Salas, 1993). After using a helicopter gunship computer game to observe crew communication patterns, Bowers, *et al.* (1992) remarked that there could be many advantages in using PC-based simulation for studying team behaviors and processes. Likewise, Baker, *et al.* (1993) discovered that military pilots and crewmembers favored the use of PC-based simulation for reviewing crew coordination tasks and crew resource management. In another study Jentsch and Bowers (1998) found that "most crews displayed performance behaviors that SMEs found characteristic and typical of aircrews in similar flight situations" (p. 247). Although these studies focused primarily on intracockpit team training, the performance measures used could be transferred to an intercockpit environment in order to evaluate similar behaviors in an aircraft to aircraft scenario.

There is also some literature concerning the training effectiveness of high fidelity simulation versus low fidelity, and consequently low cost, simulation. Salas, *et al.* (1998) indicated that there is an assumption that a high level of scene detail and motion contribute to "the realism of the out-of-cockpit view that is seen by the trainee" and that this high scene detail "consequently enhances training" (p. 202). However, Salas, *et al.* (1998) go on to reference other research suggesting that there may be more training transfer under conditions of lower scene detail as opposed to high or moderate scene detail (Taylor, Lintern, Koonce, Kaiser, & Morrison, 1991), and that 'complete physical fidelity is rarely required for effective training and transfer' (Flexman & Stark, 1987, p. 1031). In addition, the research of Stout, Salas, and Merket (1998) indicates that though low-cost, low-fidelity simulation may not be completely realistic in terms of physical characteristics, it can be "specifically designed to elicit desired KSAs [knowledge, skills, and attributes] thus maintaining functional fidelity" (p. 311).

Additionally, there is some question as to whether or not high fidelity simulators are effective in evaluating training. These simulators frequently "do not collect performance measures that can be readily used in training evaluation" (Salas, *et al.*, 1998, p. 204). Low-fidelity simulation, however, may provide better occasions for evaluating various levels of training (1998). Whether PC-based simulation can be used effectively for intercockpit team training remains to be conclusively proven.

2.7 Research Questions

In considering all the complicated aspects of training system design, it is clear that developing a relevant and cost effective training device is no easy task. As the literature review has revealed, more research is needed in the area of using low-cost simulation for training U.S. Army aviators in SA. Though there are a multitude of issues to address in the development of such a prototype, far too many for the scope of this research, the information uncovered thus far does pose some key questions. Foremost among these are: 1) What are the behaviors or skills that would need to be observed during *intercockpit* helicopter operations?, 2) Can some or all of these behaviors be extracted from cases in which the TARGETs methodology has been used to assess SA in simulations involving *intracockpit* activities?, and 3) What conceptual, low-cost framework can be used to serve as a reference point for utilizing the extracted TARGETs behaviors? The remainder of this research will address these questions.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Research Concept

Thus far this research effort has examined teamwork, SA, and methods for measuring indicators of team performance as they relate to SA. Now this research effort will address the formulation and extension of behaviors that can be used in a low-cost scenario to train and assess U.S. Army aviators in the areas of team performance and SA. The methodology will consist of case-based "extraction" from scenarios in other studies that have addressed SA with regard to aviation team training. Though these particular cases may not have specifically addressed intercockpit team training and/or were not conducted in a low-cost simulation environment, these cases may be useful in determining if the communicated behaviors used in these scenarios can be transferred to the intercockpit environment, thus extending the mission space of the assessment tool. The case selection will focus on those that have utilized the TARGETs methodology for assessing observable behaviors as they apply to SA. The two cases that will be examined are *Team Performance in Multi-Service Distributed Interactive Simulation Exercises: Initial Results* (Oser, R. L., Dwyer, D. J., & Fowlkes, J. E.,1995) and *Improving the Measurement of Team Performance: The TARGETs Methodology* (Fowlkes, J. E., Lane,

N. E., Salas, E., Franz, T., & Oser, R. L., 1994). Both of these cases were addressed in Chapter 2.

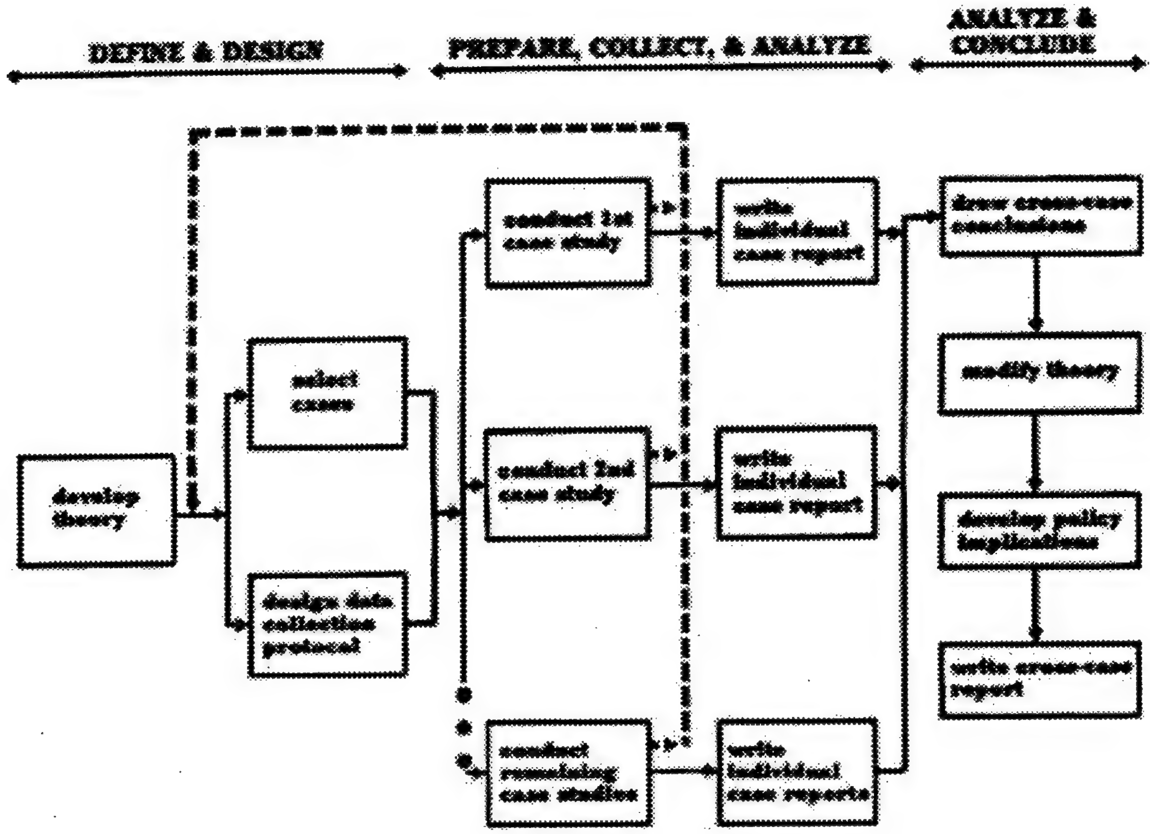
This research approach will closely follow the methodology described in Robert K. Yin's book *Case Study Research: Design and Methods; Second Edition*. The observable behaviors extracted from the cases will be modified as required for Army helicopter operations. They will then be placed into a "new" TARGETs checklist and reviewed by three Subject Matter Experts (SME) in the rotary wing and U.S. Army aviation community: two Army instructor pilots and one retired Marine Corps officer with expertise in multi-ship helicopter operations. Should additional tasks/behaviors relevant to Army multi-ship rotary wing operations be required or not required, they will be formulated and added/deleted in accordance with Army doctrine and the foundations in SA provided by the literature and case reviews.

In addition to the development of observable tasks, the case study effort will consider the feasibility of performing an intercockpit training exercise utilizing the newly formulated TARGETs checklists. The scenario will be based on an Aircrew Training Manual (ATM) or other mission-based scenario. It will be analyzed to determine if it is feasible, if the scenario exercises all of the indicated intercockpit tasks, and if the checklist supports the given scenario. In addition to the scenario and TARGETs development, a low-cost conceptual model formulation will also be conducted. This model will provide a framework in which to use the new TARGETs assessment tool. No formal attempt to prove or validate this conceptual model will be addressed during this

research effort; however, suggestions for the validation and use of such a model will be discussed in Chapter 5. To collect data from the indicated SMEs, a questionnaire will be used to address specific questions concerning the TARGETs development.

3.2 Case Study Approach

This case study extraction and conceptual model development effort will consist of three phases. These phases and the critical activities that comprise each phase are illustrated in Figure 5. Phase I, representing the "Problem Definition and Case Study Design" phase, involves defining the problem space, developing a hypothesis to address the specified research questions, selecting specific cases to assist in problem-solving, and establishing the data collection protocol for the case-based extraction. Phase II, the "Preparation, Collection, and Analysis" phase, focuses on collecting and analyzing data from each case study and ends with a written summary of the significant findings for each case. Phase III, the "Analysis and Conclusion" phase, further analyzes the results of Phase II and then attempts to draw conclusions about the practical implications of applying the extracted behaviors to an intercockpit TARGETs assessment tool.



<u>Figure 5.</u> **Case Study Research Approach Critical Activity Flow Diagram (Taken from Robert K. Yin's *Case Study Research: Design and Methods; Second Edition*)**

3.3 Phase I: Problem Definition and Case Study Design

As was suggested in Chapters 1 and 2, there is limited existing literature that demonstrates significant in-depth research on intercockpit team training in a low-cost environment, particularly in the area of SA. Focus on U.S. Army aviation training in this capacity is equally, if not more, limited. Chapter 2 indicates that there is substantial support for the use of communication or communicated behavior as an indicator of SA. Additionally, Chapter 2 suggests that the TARGETs methodology is a viable measurement tool for evaluating team training concepts, to include SA. When considering the flexible and non-intrusive nature of this methodology, TARGETs appears to be ideal for use in multiple U.S. Army rotary and fixed wing platforms. To support these assessments, much of the documentation cited referenced studies involving intracockpit or single crew coordination environments. This information, coupled with the questions posed at the conclusion of Chapter 2, suggest the hypothesis that communicated behaviors that have been determined to be appropriate for the *intracockpit* environment may be transferred to the *intercockpit* environment as an extension of the mission space.

Based on this hypothesis, the next step in this phase is to select cases that possess behaviors/scenarios that target critical teamwork skills that can be accomplished in a low-cost, multi-ship, environment. This will be accomplished through a comprehensive literature search. The search will be comprised of an examination of several different aviation experimentation situations involving team SA assessment. Two cases selected

for review are *Team Performance in Multi-Service Distributed Interactive Simulation Exercises: Initial Results* (Oser, R. L., Dwyer, D. J., & Fowlkes, J. E.,1995) and *Improving the Measurement of Team Performance: The TARGETs Methodology* (Fowlkes, J. E., Lane, N. E., Salas, E., Franz, T., & Oser, R. L., 1994). These cases were selected due to their specific use of the TARGETs methodology and their focus on aviation-related team training and SA. After briefly analyzing these cases, key aspects of each case will be placed into a master tally sheet (See Figure 4) that can be referenced in order to note the specific differences between the cases.

Case	Fidelity	Simulation Type	Aircraft Type	TARGETs Design

Figure 6. TARGETs Analysis Tally Sheet

Following this analysis, specific tasks will be extracted, modified if necessary, and placed into a new TARGETs checklist based on a generic scenario that would be applicable and reasonable for Army multi-ship helicopter operations. For the purposes of this analysis, the scenario will be based upon a mission involving three or more UH-60 Blackhawk helicopters. This aircraft mission was selected due to the generic nature of the mission objectives, those in which pilots from multiple communities (attack, scout, etc) can reasonably participate. It should be noted that the scenario and resultant TARGETs checklists can be easily modified for attack and reconnaissance aircraft

missions as well. Task selection will be based upon doctrine suggested by Army literature, the appropriate aircraft ATM, personal experience, and SME review.

The last step in this phase is the data collection protocol. This step contains the procedures and general rules that will be followed when studying the two cases. In general, the extraction of tasks from the cases will be done in accordance with U.S. Army aviation operational guidelines outlined in doctrinal publications and relevant aircrew training manuals. Both the TARGETs assessment tool and the scenario will be distributed to the SMEs for review and modification.

3.4 Phase II: Preparation, Collection, and Analysis

Phase II will be the actual case study and task extraction phase. This phase will prepare, collect, and analyze data for each case study. This phase will be guided by the protocol established in section 3.3 and will draw upon several different sources of information to ensure a thorough analysis. This will include the information discussed in the previous chapter. Additionally, as tasks are extracted from the case studies, they will be placed sequentially into the TARGETs checklist that will be subsequently used in an intercockpit training scenario.

3.5 Phase III: Analysis and Conclusion Phase

This phase builds upon the analysis that ended Phase II and concludes with the implications that the case studies might hold on the proposed hypothesis. The findings in this phase will constitute a significant portion of Chapter 4 in this thesis. This phase will augment the case-based task extraction discussed in the previous sections. This augmentation will be done through the use of SME review. The newly developed TARGETs checklist containing observable SA behaviors will be submitted to experts in the U.S. Army rotary wing community: two instructor pilots and one former officer with expertise in multi-ship helicopter operations. They will provide feedback on these checklists through the use of a pre-designed survey and comment sheet.

The review will have the following objectives:

- Determine if the given scenario realistically represents characteristics typical of a multi-ship operational environment.
- Determine if the behaviors listed in the TARGETs checklist accurately represent those that would be exhibited in a multi-ship helicopter environment involving two or more utility or attack helicopters.
- Determine if there are additional tasks/behaviors that should be added to, or deleted from, the scenario.

Once the TARGETs checklist has been reviewed, an analysis of the feedback from the SMEs will determine whether or not, and/or to what degree, observable tasks

can be extracted from other TARGETs checklists used in other simulation cases. This analysis will provide support for or against the proposed theory and research questions posed in section 2.7. The SME feedback will then be used to modify the draft TARGETs checklist. The resultant product for this thesis will be a new TARGETs checklist that can be eventually used to assess SA in U.S. Army aviators participating in a low-cost simulation exercise.

3.6 Conceptual Framework

Though the assessment tool can be developed independently from the other components of this low-cost training system, it is necessary to have a framework in which we expect to use this tool. As indicated in section 3.1, the tasks formulated for the new TARGETs checklist will be extracted from cases that have a varied base of origin: from those involving a single, high-fidelity simulator to those involving multi-service, high-cost distributed simulation exercises.

By examining certain aspects of these and other cases and the fidelity issues discussed in Chapter 2, it is once again possible to extract a conceptual framework that can provide a baseline for what type of hardware configuration, software requirements, and other equipment might be sufficient for a low-cost representation for team training. To achieve this, case-based research will be used to formulate a conceptual model for a low-cost simulation environment that can best serve the needs of evaluating team SA, yet still be of practical use for the military in terms of flexibility and deployability. For the purposes of this research, "low-cost simulation" will be restricted to the domain of PC-based systems, since the PC would afford the Army aviation community reconfigurability and ease of deployability.

The cases chosen for analysis are *Individual Task Proficiency and Team Process Behavior: What's Important for Team Functioning* (Stout, Salas, & Carson, 1994) and *Communication and Team Situational Awareness* (Bowers, Braun, & Kline, 1994). A logical question one could pose is why were these cases selected over the myriad of other

cases involving the use of PC-based simulation? These particular cases were selected due to their focus on subject areas relevant to this research effort. Both cases examine one or more aspects of team training, and one case, Bowers, et. al., 1994, specifically addresses the relationship between communication and SA. Additionally, both cases focused on aviation-related skills and scenarios. In much the same manner as the case-based extraction methodology used to develop the TARGETs checklists, key elements of the two cases given here will be extracted and placed into the conceptual framework.

There is a myriad of possible components that could be considered in this case comparison. However, it would be unfeasible to adequately address them all in this analysis. For the purposes of this research, only the components illustrated in Figure 7 will be considered in each case. These components have been broken down into the categories of internal and external. The "Audio" category is overlapping due to the fact that PC speakers, microphones, and headsets may be used as either internal devices to the system or as an external means of communication or review. Other specific components, such as graphics boards and sound cards, will not be addressed. A master chart will be used to track, categorize, and compare/contrast each of these elements (See Figure 8). Added to this checksheet is an additional column for Team Training/SA. The inclusion of this column is to document whether the case in question does, indeed, concern team training issues, SA issues, or both. From this analysis, it will be possible to develop a conceptual model that represents a low-cost simulation environment in which to apply the TARGETs assessment tool.

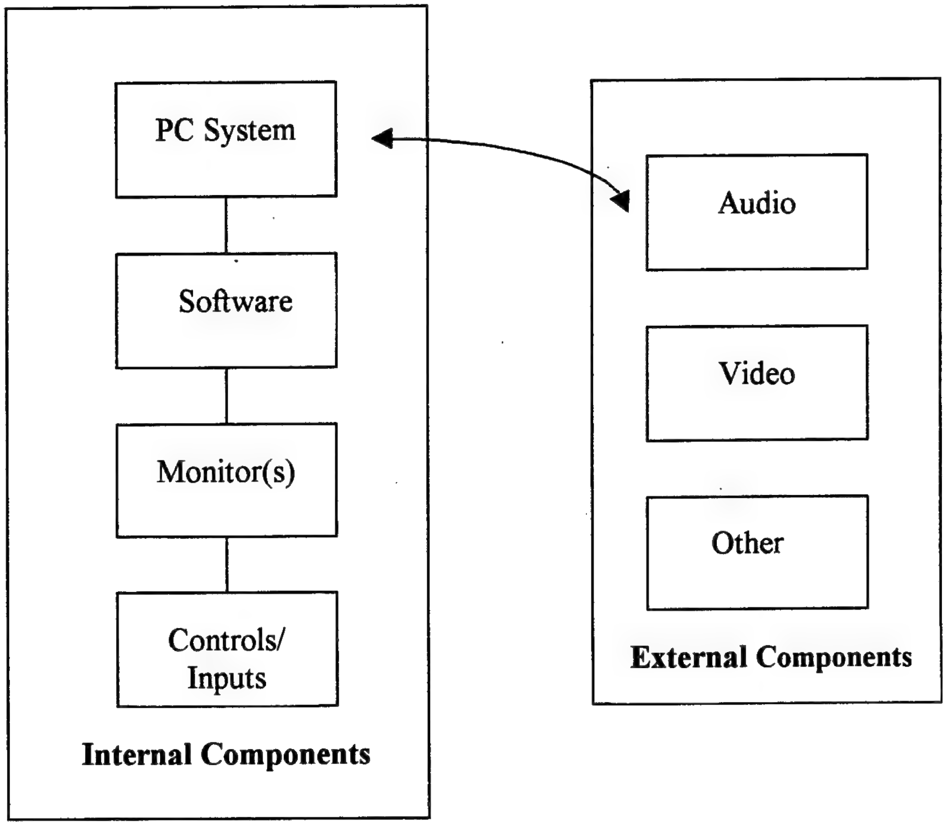


Figure 7. **Low-Cost Conceptual Model Components**

Case	Team Training/SA?	PC System	Software	Controls

Case	Monitors	Video Equipment	Audio Equipment	Other

Figure 8. **Conceptual Model Master Checksheet**

This conceptual model development will follow the same "three-phase" procedure used for the TARGETs assessment tool. The two cases will be analyzed, and key components will be extracted and compared for possible application in a low-cost system. It is important to note that the primary focus of this research involves the design of a team training assessment tool through the development of a TARGETs checklist. No formal proof or validation of this conceptual, PC-based framework will be conducted beyond what has already been done for the conceptual model and limited user comments on the feasibility and viability of such a system.

CHAPTER 4

CASE RESEARCH AND ANALYSIS

4.1 TARGETs Analysis Case 1: *Team Performance in Multi-Service Distributed Interactive Simulation Exercises: Initial Results*

Since Desert Storm, the military has seen an increasing reliance upon geographically separated, multi-service units that must work together to perform a variety of missions (Oser, R. L., Dwyer, D. J., & Fowlkes, J. E., 1995). This particular study examined the use of advancements in distributed interactive simulation (DIS) technologies for use in a Multi-Service Distributed Training Testbed (MDT2) exercise in Close Air Support (CAS). Using the TARGETs methodology, performance data was collected over the course of the five-day exercise. Ultimately, recommendations were provided concerning the future evaluation of team performance concepts in similar DIS environments (1995).

The MDT2 for this study involved a system of moderate to high fidelity simulators located at several military training and research facilities around the nation to include the Mounted Warfare Testbed, Ft. Knox; Armstrong Laboratory, Aircrew Systems Training Division, Mesa, AZ; and Naval Command Control & Ocean Surveillance Center Research and Development, NRaD, San Diego, CA. The players

consisted of a variety of vehicles and aircraft types, e.g. helicopters, F-15s, and F-16s. Networking between the sites was accomplished through the Defense Simulation Internet (DSInet) and the use of T-1 lines. Additionally, communications were provided through digital voice (1995).

The scenario package included a comprehensive mission that was comprised of a series of separate flight segments. It began with the mission brief and continued through preflight and take-off procedures into the conduct of an actual in-flight mission. During the mission, each site may or may not have been involved in multiple activities including ingress, egress, target engagement, air intercept, and attack. At the conclusion of the mission, teams were debriefed on their performance in several categories, one of which being SA.

The desired behaviors for this exercise were represented in a series of TARGETs checklist like the example shown in Appendix B. They were designed very much like a standard TARGETs checklist, with the exception of columns three and four. Instead of using a mark or symbol in column three to represent a "hit" for the indicated behavior, grades are placed in these blocks. This allows the observer to not only indicate whether or not the desired behavior was observed, but also to assess the degree of proficiency in which the behavior was executed. The grading scheme used in evaluating the behaviors is also shown in Appendix B. In this scale, the various dimensions being analyzed are outlined with concrete descriptions of what to look for in the behaviors. Below this, a numeric scale is given to provide evaluators with guidance for assigning grades.

Depending on the objectives of a particular study or training scenario, evaluators may be able to glean a more precise assessment of a team's SA through the use of such a grading scheme. Also of note is the implementation of a "notes" column. This enables the observer to document key information, specify which crew or crewmember actually elicited the behavior, or elaborate on certain aspects of the behavior not provided in the "behavior" column.

4.2 TARGETs Analysis Case 2: *Improving the Measurement of Team Performance: The TARGETs Methodology*

The goal of this study was to demonstrate the use of an event-based measurement technique, specifically TARGETs, in evaluating team performance for potential military applications. The study argued that stimulus events could be used to serve as cues for team members in order to elicit certain desired behaviors that one can place into categories such as leadership, assertiveness, decision making, and SA. The scenario required six aircrews to fly a troop transport/extraction mission in which they would encounter a variety of situations to include change of flight lead and lost communications (Fowlkes, J. E., Lane, N. E., Salas, E., Franz, T., & Oser, R. L., 1994). To execute the scenario, the crews utilized a high-fidelity, 6-*df* motion base operational flight trainer (OFT) which replicated major aircraft systems while providing left and right side, right front, and chin-bubble outside visuals (1994).

The TARGETs checklists derived for this particular study were similar to those of Case 1. In this instance, however, the checklists were designed for a more objective and quantifiable approach to evaluation. Each of the events and behaviors was coded for a specific phase of the mission (e.g., preflight) and a specific aspect of performance (e.g., equipment status or information awareness). The number of "hits" for each phase and each category were then recorded in a tally sheet that encapsulates the overall results of the exercise. With this approach, evaluators can use the various totals in each category to

statistically quantify how the team performed. Examples of the TARGETs checklist and final tally sheet used in this case are shown in Appendix C.

4.3 TARGETs Case Comparison and Products

By analyzing the two cases in sections 4.2 and 4.3, key similarities and differences surface. These can be noted by referencing the tally sheet below (see Figure 9). Though both studies were conducted in a high-fidelity environment, each case used a different approach for "connecting" their teams. Case 1 used DSInet to connect the various multi-service elements, while Case 2 used a single OFT. Both cases also used rotary wing aircraft in their exercises; however, Case 1 was far more complex and involved the use a variety of aircraft and vehicles. Additionally, each case used a slightly different approach to their TARGETs checklist design. Case 1 used a more subjective, grading-oriented approach to evaluating behaviors, while Case 2 used an objective "observed " or "not observed" technique for recording elicited behaviors.

Case	Fidelity	Simulation Type	Aircraft Type	TARGETs Design
Team Performance in Multi-Service Distributed Interactive Simulation Exercises	High	- DSInet - Multiple Sites	-Helicopter -F-15 -F-16 -A-10	-Subjective -Use of grading scheme -Notes column added
Improving the Measurement of Team Performance	High	Single, full-motion simulator	Cargo helicopter	-Objective -"present" or "not present" approach to behavior evaluation

Figure 9. Final TARGETs Analysis Tally Sheet

Through an examination of Army literature and the cases discussed in the previous sections it is possible to derive a viable scenario from which to develop the new events and behaviors for the TARGETs checklist. The scenario constructed for this

research is shown in Appendix D. It represents a generic troop extraction mission that a flight of Army utility helicopters would be expected to execute. It begins with a mission brief to flight crews by the air mission commander (AMC) and is followed by a troop extraction mission at some predetermined pick-up zone (PZ). The scenario ends with the flight safely returning to base after the troop extraction. During the mission, the crews will encounter unexpected events to which they must react in a safe and doctrinally appropriate manner. The scenario does not specify exactly what these events will be, but does alert crews to the fact that they will most likely respond to some in-flight change or mission deviation.

The events and behaviors that correspond to this scenario have been placed into a preliminary TARGETs checklist also depicted in Appendix D. The checklist format represents a hybrid of the two checklists discussed in the two previous sections. It combines the subjective note and grading components of the checklist from Case 1, yet allows for the objective and straightforward "present or not present" approach used in Case 2. Evaluators may choose whichever technique is appropriate for the situation. The mission itself has been broken down into several segments that range from the mission brief to return to base.

By comparing the tasks present in this new checklist to those from the two cases discussed in this research, it is evident that the extracted tasks are very similar to those in the original studies, yet clearly tailored to fit Army intercockpit helicopter applications. One example of this is the use of more multi-ship-oriented references such as AMC and aircraft (AC) as opposed to just pilot or copilot. Additionally, for many tasks it is not

imperative to know exactly who demonstrated a behavior, as in Case 2, so long as that crew executed it without being prompted. If the rater so desires, the notes column can be used to specify who demonstrated the behavior.

Also of note is the clear distinction on the TARGETs header whether or not the AMC is in the rater's particular crew. The AMC bears all the responsibility for the conduct of a multi-ship operation, and is, therefore, required to be aware of more elements in the environment. Distinguishing this on the checklist allows the rater to focus on the AMC specific tasks while other crew raters can simply mark these tasks as "not observed" or "not applicable" (N/A). To assist raters with their notation and provide consistency in the evaluation process, a legend has been included at the bottom of the first page.

It should also be noted that not all of the events and behaviors from Cases 1 and 2 could be extracted for use in the extended intercockpit mission space. One key reason for this is the distinction between the relatively high-fidelity simulation environment of the cases and the low-cost, low-fidelity environment of our training system. Without a cockpit that replicates all the switchology, communications equipment, and flight controls of the actual aircraft, it is not possible to do a complete preflight check and taxi. Also, depending on the audio constraints of the low-cost system, communications techniques, such as "frequency hopping", will certainly be limited. The type of hardware components and audio-visual support that may be used for this training system will be discussed in greater detail in future sections concerning conceptual model development.

In addition to the scenario and preliminary TARGETs checklist, a survey sheet has been developed for use during the SME review. This survey sheet, depicted in Appendix E, asks the SMEs to address the key objectives posed in section 3.5. Specifically, it asks the SMEs to determine: 1) if the scenario realistically represents a mission conducive to Army multi-ship, utility helicopter operations, 2) if the given events in the TARGETs assessment tool follow an appropriate sequence for such a mission, and 3) if the listed TARGETs behaviors are representative of what multi-ship crews would be expected to perform. The survey also provides comment space for each question so that the SMEs may add, delete, and/or make changes to the current tasks.

The survey sheet, scenario, and preliminary TARGETs checklist was forwarded to the appropriate SMEs for review. Their feedback is discussed at the end of Chapter 4. The TARGETs products were modified as necessary to reflect the changes suggested by the SMEs. After modifying these items the resultant products consisted of a scenario and accompanying TARGETs assessment tool to use for training Army aviation is a low-cost simulation environment.

4.4 SME Review of TARGETs Checklist

The SME feedback from the TARGETs assessment survey is shown in Appendix F. The SMEs unanimously concurred that the given scenario was representative of a multi-ship mission that Army utility helicopter aviators can expect to encounter. The TARGETS checklist developed for the hypothesized low-cost simulation framework suggests that communicated behaviors that have been used in a variety of other team training simulation environments can be extracted for use in an intercockpit environment. Though not every task could be transferred to the assessment tool, the SME review did indicate that a majority of the selected/developed behaviors and tasks incorporated into the new TARGETs checklist were adequate and required only minor modifications to reflect Army Aviation specific considerations.

Though they viewed the checklist as a viable assessment tool as is, the SMEs did comment on the seemingly copilot-oriented nature of the tasks and indicated that at times it was difficult to see the multi-ship application. This comment suggests that a more general checklist for one observer may be better suited for capturing intercockpit behaviors. The effectiveness of this approach, however, would be dependent on the observer's visibility of the crew stations and access to the intercockpit communications. In addition, the SME's commented on the potential need for segments involving emergency procedures and enemy threats.

It should be noted, however, that this data is representative of only a small sample of SMEs (N=3). With such a small sample size of experts, a reliable determination of

statistical significance and/or bias of the survey is not possible. Though every effort was made to select objective SMEs with backgrounds appropriate for assessing utility helicopter operations, some form of bias is inevitable. It is also noteworthy to point out that these products constitute only a preliminary research effort with the objective of developing an initial viable TARGETs checklist. Subsequent, more extensive testing is necessary in order to legitimize its use.

4.5 Conceptual Model Case 1: *Individual Task Proficiency and Team Process Behavior: What's Important for Team Functioning*

This specific case attempted to examine effective team performance as it relates to task proficiency beyond individual team members (Stout, Salas, & Carson, 1994). During this experiment, male and female undergraduate students were distributed into two-member crews consisting of a pilot and copilot. Though each crewmember was assigned specific tasks to accomplish, coordination between team members was necessary in order to complete mission objectives. The crews were required to "fly" a scenario with the aid of a low-fidelity, low-cost flight simulation apparatus. Task proficiency was measured in terms of joystick controllability, copilot keyboard operation, and number of targets killed.

The hardware configuration selected for this experiment was comprised of a low cost, off-the-shelf (OTS), PC-based system, an audio system, and a form of video recording system to be used for feedback and after action review (AAR) purposes (1994). The personal computer system included a modest 286 IBM compatible PC, four-channel video splitter, joystick, keyboard, and Micro Prose's *Gunship* software. For visual displays, three monitors were used. Two of the monitors provided each crewmember with a separate display, while the third monitor was used to display the team's performance. The availability of the channel splitter provided for simultaneous viewing of video images at three separate locations. No haptic feedback devices were indicated or suggested.

The audio equipment used was fairly simple as well. All components could be easily and inexpensively purchased at a local Radio Shack® or audio-visual supply establishment. In order for the crewmembers to communicate while performing their tasks, they were provided with Radio Shack® lapel microphones and lightweight headphone sets. With the aid of a mixing board, the headphone sets and microphones could be connected and the output, subsequently incorporated into the audio portion of the videotape (to be discussed in further detail below).

For monitoring and recording the performance of each team, this experiment included a portable video camera, a video tape recorder, connecting cables for incorporating the output from the mixing board into the recorder, and a basic black-and-white television set. Additionally, a tripod was used for mounting and positioning the portable camera. This collection of video components allowed for the progress of the team, which was displayed on the third monitor, to be received on the television. Subsequently, this picture could be transmitted from the camera to the recorder. In order to facilitate crewmember communication and coordination for task completion, two partitions were used to separate the crewmembers from each other and the video/observation station.

4.6 Conceptual Model Case 2: *Communication and Team Situational Awareness*

This particular study addressed the use of communication patterns as a means to investigate performance on simulated flight tasks engineered to demand a high level of SA. Twenty instrument flight rules (IFR) rated pilots participated in the study and were required to complete a variety of tasks over the course of a two-phase experiment (Bowers, Braun, & Kline, 1994). The twenty participants were subsequently broken down into ten crews of two.

The components selected for this study were relatively simple, easily obtainable, and certainly low-cost. The hardware consisted of a 386, 33 MHz IBM compatible computer with keyboard, optional joystick, and a single VGA monitor. The software consisted of the low-fidelity simulation program Flight Simulator 4.0. For the purposes of this study, the software was configured to represent a Cessna 210.

Crews were able to view navigational aids, instrument panel indicators, and external visual scenes on the single monitor. Audio and recording equipment was limited to the speakers accompanying the PC system, and a video recorder documenting the actions of each crew. No microphones or headsets were used, or were not indicated in the case. Haptic feedback devices were also not present or suggested.

4.7 Cross Case Comparison

Through the component analysis discussed in sections 4.5 and 4.6, each case's respective key elements have been placed into the master checksheet alluded to in section 3.6. The resultant product of this process is the Conceptual Model Cross Comparison Checksheet depicted in Appendix G. An examination and comparison of these two cases reveals some interesting issues for consideration. Though each case approached the survey of team training and/or SA concepts in much the same manner, the complexity of each case's design is very different. Ultimately each case provided elements that could be applied to the conceptual model.

One item that immediately stands out in this comparison is the relatively "slow" processing speed of the chips used in the PC configuration. Though both these studies are more than three years old, the use of 286 or 386 chips for team training does show that the fastest and most expensive processor available may not be required for a low-cost, low-fidelity system. A moderately priced Pentium® III based PC should satisfy the needs of this training system's software and multi-ship requirements. Since the new low-cost system will involve the participation of multiple aircraft and not just one crew, the use of one PC-system per aircraft would be required. Additionally, the software selected for these systems should possess a network capability for multiple player use. Microsoft Flight Simulator, or a similar package, can provide this type of capability.

Both cases suggest that some form of video or after action review capability is essential for monitoring and documenting team performance. As indicated in Case 1, this

method of recording team activities allows the observer to review specific team behaviors and communications after a crew has completed the given scenario. This is particularly helpful in facilitating the use of a TARGETs checklist. By reviewing a video recording of the crew's performance, an observer may reevaluate behaviors originally thought to be present, but were not, or provide credit for those that may have been present but were missed.

The use of visual displays in each case is very different as well. Though Case 2 illustrated that one monitor can be used for team training applications, this design may be more suitable for intracockpit team training as opposed to intercockpit. Since the proposed hypothesis suggests an "extension" of the mission space for multi-ship operations, the multiple monitor setup demonstrated in Case 1 would be more conducive for evaluating team concepts and communicated SA behaviors. This is due to the fact that this type of setup supports multiple player use, multiple visual scenes, if needed, and the viewing of subject performance by an observer.

Also of note is the use of partitions in Case 1. Since the literature and the new TARGETs checklist suggest that communicated behaviors can be fundamental indicators of team SA, the use of partitions would facilitate these behaviors. Additionally, the use of partitions could provide an environment that is more closely representative of what elements are actually within a crew's purview. Since an aircraft crew in an actual multi-ship environment cannot "see" the crews of other aircraft, it would be unrealistic to implement a conceptual model that allows separate crews to view each other and possibly

derive information or increased SA through the observation of facial expressions or physical gestures.

Conspicuously missing from both cases was the use of haptic devices. As the Chapter 2 discussion on fidelity suggests, high fidelity may not be as critical when the desired training is behavioral as opposed to psychomotor. In both of these cases the focus centered on training team performance concepts, not flight skill proficiency. When considering the implications of this for a low-cost system, it follows that components such as haptic feedback chairs or flight controls may provide limited or even negligible benefit.

With these differences in mind, this analysis suggests that an ideal low-cost, PC-based system for conducting intercockpit team training would consist of components drawn from both cases. A depiction of this conceptual model is shown in Appendix G. The components would consist of the following:

- A standard desktop PC with a minimum of a Pentium® III chip.

- An OTS aviation software package that can be configured for a specific aircraft's visual and instrumentation displays and networked for multi-player use.

- Joysticks and flight controls only as needed or as funds permit.

- A communications architecture for simulation connectivity.

- An audio/communications system consisting of PC speakers, microphones and headsets.

- A video recording system that can monitor team flight performance and crew behavior.

- Multiple monitors and channel splitters (as required) for aircraft representation and evaluator observation.

- Partitions to separate individual aircraft crews from each other and the evaluators.

It is important to note that the connectivity between these individual crew stations is based upon a simple local area network (LAN) or modem-based internet configuration. Due to the fact that the use of an advanced simulation communication protocol, such as high level architecture (HLA), would drive the cost of the system out of the low-cost arena, this type of connectivity was not considered in this research.

CHAPTER 5

CONCLUSIONS

5.1 Results

As indicated in the analysis in Chapter 4, the SME review suggested that the developed scenario and TARGET assessment tool were valid products that could be used to train and evaluate Army aviators in SA. Though their comments brought out the need for minor changes, such as the addition of segments for emergency procedures, and indicated some lack of clarity in discerning multi-ship behaviors, they did feel that the scenario and checklist were viable tools.

This research also proposed a low-cost conceptual model in which to use the new TARGETs checklist. An analysis of the cases presented suggested a multi-monitor system and reconfigurable software that could be used with a conventional desktop Pentium® PC. Of note is the fact that neither case made use of haptic feedback controls. This point provides support for the concept of using lower fidelity simulation for behavioral/cognitive applications. Though not presented in either of the cases, the concept of multi-monitor use for each crew station may be of considerable benefit. This configuration would allow a wider viewing area for the pilot(s), e.g., for acquiring other aircraft in the flight, and could allow for a separate monitor for cockpit instruments.

Although there was no formal effort to validate this model, it can act as a starting point for further research. Approaches to this research are discussed in the next section.

Despite the optimistic results obtained by this research, it should be noted that the TARGETs checklist developed here and the supporting low-cost conceptual model are "pilot" products, and much further in-depth research is needed to truly validate the TARGETs assessment tool. This would involve the conduct of the given scenario in an actual low-cost environment and a further analysis of the task interreliability. In order to assess whether or not the tasks in the checklist are relevant for evaluating SA, factors for determining task interreliability would need to be developed. Additionally, an application of psychometric theory may be needed in order to determine the interreliability among raters and correlation between tasks and subject performance (Nunnally, 1967).

5.2 Lessons Learned

The process of conducting this research has brought out some very noteworthy lessons learned. Foremost among these is the realization that capturing the key components and measurement of SA is a tedious and difficult process. This is exemplified by this checklist's difficulty in projecting SA into the future. A thorough examination of SA assessment and its application in a low-cost simulation environment involves the integration of many disciplines such as research psychology, behavioral science, physiology, and computer science. To truly assess SA, each of these areas must be examined and integrated into the research process in order to determine how each factor affects the others. Even more important is the determination of a universal definition of SA. In order to develop a checklist that truly captures SA, one must be able to refer to and rely upon a definition that is accepted and well-supported.

Just as the incorporation of multiple disciplines would enhance experimentation in SA, the use of multiple performance measures may also benefit the research process. The new TARGETs checklist developed in this research may have been better supported by the integration of additional SA performance measurement technique. One example of this would be the use of the SWORD method discussed in Chapter 2. Since the focus of this research did not include the actual testing of the checklist in a low-cost simulation environment, the relationship between, and the comparison of, the two techniques was not viable. However, it cannot be denied that the use of multiple performance measurement techniques would lend greater credibility and reliability to SA assessment.

Another issue brought out in this research was the difficulty in capturing intercockpit versus intracockpit tasks. Though the tasks in the new TARGETs checklist did address communicated behaviors between members of different aircraft crews, the SME survey comments suggest that this distinction was not always clear, and that the predominance of the tasks seemed to focus on intracockpit activities. This indicates that the line between what is viewed as an in or out-of-cockpit behavior is greatly dependent upon the SME's opinion of the scenario and how the scenario's tasks are sequenced. Certain sections of a mission may involve very intracockpit-heavy procedures, but still require key intercockpit communications to demonstrate multi-ship, team SA. Determining a balance between the two continues to be a challenge.

Checklist reliability, as indicated in section 5.1, may have been improved as well. Had time and resources been available, more sound results could have been achieved by sending the checklist out for SME review a second time after making changes. This process would have enabled the assessment of improvement in the checklist development. Additionally, the reliability of the SME's could have been made more sound by inserting false or "bogus" tasks to ensure that they were, indeed, reading the detailed tasks of the checklist closely.

5.3 Areas for Future Research

As indicated earlier in this research, the design, implementation, and validation of any proposed training device are difficult tasks requiring a tremendous scope of research and experimentation. However, this research effort's seemingly limited emphasis on the development of a SA assessment tool and a preliminary conceptual framework can act as a springboard for other relevant areas of research. One such area involves the formal validation of the low-cost conceptual framework discussed in section 4.7. A more thorough examination of the environmental components suggested would provide a foundation of empirical data that will either support or not support the hypothesized conceptual framework. This could be accomplished through a two-step process involving the testing of the low-cost platform itself and the testing of the TARGETs checklist within the low-cost environment. The first step would indicate whether or not the derived components of the conceptual model could support the given multi-ship scenario and accompanying events, behaviors, and responses. Following this process, the TARGETs checklist would be implemented, using crews of Army helicopter pilots, in order to determine the checklist's viability. The ultimate objective would be to reexamine the checklist in an actual operational setting.

There are also issues that surround the use of the new TARGETs checklist as an intercockpit SA evaluation tool. Though the tasks formulated in this research are directed at use in multi-ship helicopter operations, it should be noted that the intracockpit aspects of SA and other dimensions do not simply disappear. The SME survey comments and

the discussion in section 5.2 concerning tasks formulation difficulty further emphasize this fact. This notion suggests that the use of multiple or composite TARGETs checklists, those for intracockpit and intercockpit assessment, may be valuable in determining SA on several levels. Based upon the earlier discussion concerning task interreliability, psychometric application would be even more crucial in determining the validity of such a complex structure of intracockpit and intercockpit behaviors.

Another key area of emphasis for further analysis concerns evaluating the training effectiveness of such a low-cost training system and assessment tool. This begs a query as to the intended use of this low-cost system and assessment tool. The intent of this research was not to develop a tool that could be used to provide direct training benefit from the low-cost environment to the actual aircraft. Instead the focus was on providing a tool that could be used as a stepping stone to the next level of simulation: the high-fidelity environment.

In order to assess this effectiveness accurately, it would be necessary to ascertain the amount of training transfer that occurs in the transition from the low-cost, low fidelity to a high-cost, high fidelity simulation environment, and, ultimately, to the actual aircraft. To research these concepts would clearly require tremendous scope and resources. Still, if it can be shown that an adequate level of positive training transfer can be obtained through the use of a low-cost system, such as the one proposed here, the implications for monetary savings, safety, pilot performance, situation awareness, and ultimately, mission accomplishment, could be invaluable.

APPENDIX A - GLOSSARY

AAR – After action review

AH – Attack Helicopter

AHP – Analytical hierarchy process

AMC – Air Mission Commander

APART – Annual proficiency and readiness test

ARMS – Aviation Reconfigurable Manned Simulator

ARNG – Army National Guard

ATM – Aircrew Training Manual

AVCATT – Aviation Combined Arms Tactical Trainer

AVTB – Aviation Test Bed

CATT – Combined Arms Tactical Trainer

CAS – Close Air Support

CP – Copilot

CRM – Crew Resource Management

DA – Department of the Army

df – Degrees of freedom

DoD – Department of Defense

DIS – Distributed interactive simulation

DOTDS – Directorate for Training, Doctrine, and Simulation

DSInet – Defense Simulation Internet

EEG – Electroencephalogram

FRED – Fully Reconfigurable Engineering Device

HLA – High level architecture

KSA – Knowledge, skills, and attributes

LAN – Local area network

MDT2 – Multi-Service Distributed Training Testbed

OFT – Operational flight trainer

OTS – Off-the-shelf

PC – Personal computer

PCATD – PC-based aviation training device

PEO Avn – Program Executive Office for Aviation

PIC – Pilot-in-command

PZ – Pick-up zone

SA – Situation awareness

SAGAT – Situation Awareness Global Awareness Technique

SART – Situation Awareness Rating Technique

SIMNET – Simulation Network

SME – Subject matter expert

STRICOM – Simulation, Training, and Instrumentation Command

SWORD – Subjective Workload Dominance

TARGETs – Targeted Acceptable Response to Generated Events or Tasks

UH – Utility helicopter

USAAVNC – United States Army Aviation Center

WP - Waypoint

APPENDIX B - TARGETs ASSESSMENT TOOL DEVELOPMENT: CASE 1 EXAMPLES

BRIEFING	BEHAVIOR	Grade	Notes
	Review tasking, mission, intel brief	3	
ROE	Review ROE	2	NOT ACCOMPLISHED DURING BRIEF
OPERATING AREA	Review route; entry point, target area, egress	3	
	Review boundaries; FEBA	3	
STRIKE COMPOSITION	Review team members and team member responsibilities (F-16, AWACS, A-10)	3	
	Review aircraft types and implications	—	
	Review ordnance loadout	—	
RENDEZVOUS	Review rendezvous procedures (position, attitude, speed, formation, contingencies)	3	
	Review contingencies for rendezvous	3	
	Review check-in procedure; alpha check	2	NOT BRIEFED
COM PLAN	Review comm plan (Frequencies, Call Signs)	3	
AIC	Bulleyes	3	
	~~Check-in Procedure; alpha check~~	—	
	Preferred Calls	—	
	Cadence/discipline	—	
	Bullseye vs BRA	3	
INGRESS PLAN	Flow	3	
	Time Line	3	
	TOT	3	
	Ordnance employment tactics	3	
	Speed/altitude	3	
	Communication calls	2	
ACA	Indirect/Direct Fires Plan	—	
	SEAD Plan	—	
FIGHTER TACTICS	Mission allowable risk	2	NOT BRIEFED
	Position/timing	3	
	Flow	3	
	Float/strip criteria	3	
	PID engagement criteria	—	
	Blue-on-blue deconfliction	—	
	Formation	3	
	Commit criteria	3	
	Joker and bugout calls	3	
	Review roles and responsibilities of elements (monitoring, leakers, etc)	3	
	Review procedures for handling of threats	3	
EGRESS	Egress speed/altitude	3	
	Deconfliction Plan	—	
	Comm Plan	—	

INGRESS	2 Red Helos, 1 A-10, F-15, F-16, TAC-1, TAC-2, 1 Blue Helo, 2 Blue Helos, 2 Red Manned 1&2, 4 Red Strikers	Grade	Notes
(East of FEBA)			
	AWACS provides updated picture	/	
	Ack/respond to AWACS as appropriate (e.g., in v. out of range)	3	
	Fighter provides updated contact report (terminology and timing appropriate)	4	Good SA
	AWACS helps maintain picture with acceptable timing and cadence	/	
	Discuss Implications for Ingress/Egress Routes	/	
	Push Calls?	/	
(West of FEBA)	AWACS provides updated picture	/	
	Ack/respond to AWACS as appropriate (e.g., in v. out of range)	3	
	Fighter provides updated contact report (terminology and timing appropriate)	3	
	AWACS helps maintain picture with acceptable timing and cadence	/	
	Discuss Implications for Ingress/Egress Routes		
Ground-to-Air Systems	SA-2, SA-6, SA-8		
	Detection	4	Excellent RWR usage
	Avoidance	4	
	Assess Implications		
	2 Red Helos, 1 A-10, F-15, F-16, TAC-1, TAC-2, 1 Blue Helo, 2 Blue Helos, 2 Red Manned 1&2, 4 Red Strikers		
If Air Intercepts Performed during Ingress	Fighter provides descriptive calls with acceptable timing and cadence		
	Radar Search, Detection, Lock-on	4	
	Intercept Execution	4	#1 + #2 did a very good job w Sorting & engagement
	Sort call	4	
	Targeting plan communicated	4	
	Tactical Considerations discussed	3	
	Weapons employment communicated	3	
	Directive calls at merge timely and appropriate (e.g., cranking, notching, intentions (engages, blowthrough), joker, egressing)	3	
	Leaker calls (positive or possible)	/	
	Identification of Unknowns	/	

PHASES

BRIEF - this phase refers to the briefings and planning that is performed prior to the start of the mission.

PRIOR TO PUSH refers to the period of time that the participants are operating in the area east of 115 degrees (FEBA)

INGRESS - refers to period of time that the participants are operating west of 115 degrees (FEBA) but prior to engaging any air or ground targets

COMBAT AIR PATROL FORMATION - refers to the period of time that participants are in combat air patrol circling formations but not engaged

INTERCEPT ENGAGEMENT - refers to the period of time that participants are engaging an air target

GROUND TARGET ATTACK - refers to the period of time that participants are engaging a ground target

EGRESS - refers to the period of time that participants are egressing the operating area

DEBRIEF - refers to the period of time that participants are conducting any review of the mission.

DIMENSIONS

COMMUNICATION - THE EXCHANGE OF INFORMATION BETWEEN TWO OR MORE TEAM MEMBERS

DESCRIPTORS - (1) Information Exchange – involves the clear, concise, and accurate exchange of information between elements of the team, (2) Information Clarification – involves the detection of inaccurate or incomplete information and taking corrective action, (3) Information Cadence – involves the timing, rhythm, and flow of information, and (4) Information Format - involves the terminology and order of the information

SITUATION AWARENESS - THE EXCHANGE OF INFORMATION USED TO DEVELOP AND MAINTAIN AN ACCURATE PERCEPTION OF THE OPERATING ENVIRONMENT

DESCRIPTORS - (1) Maintaining an Overall Mission View - involves interactions involving mission goals and how situational factors are affecting the mission goals, (2) Monitoring Mission Deviations - involves interactions related to the detection and communication of changes in the operational environments that could affect the mission plan, (3) Monitoring Mission Progress - involves interactions related to the current location and status of mission assets, (4) Understanding Current Mission State - involves interactions that demonstrates the team's shared and common understanding of the mission status, and (5) Assessing Future Mission States - involves interactions related to potential modification of mission plan

ADAPTABILITY/FLEXIBILITY - THE EXCHANGE OF INFORMATION RELATED TO THE MODIFICATION OF PLANS

DESCRIPTORS: (1) Maintaining the Pre-Briefed Plan - involves interactions demonstrating that the team will not modify its existing plan, (2) Changing to a Pre-Briefed Alternate Plan - involves interactions demonstrating that the team will modifying its current plan to a previously briefed alternate plan, and (3) Changing to a Non-Briefed Plan - involves interactions demonstrating the team will modify its current plan to a plan that was not previously briefed

CREW COORDINATION - THE EXCHANGE OF INFORMATION RELATED TO TEAM SYNCHRONIZATION

DESCRIPTORS: (1) Providing Information in Advance - involves interactions related to team members anticipating team members needs for information and providing the information prior to its request, (2) Providing Back-Up when Required - involves interactions related to team members recognizing need for assistance and providing such assistance, and (3) Maintaining Contracts - involves interactions related to team member implicit interactions agreed upon during the mission brief

Scale:

1	2	3	4	5
Not Done/ Dangerous	Below Average	Nominal	Above Average	Extraordinary

APPENDIX C - TARGETs ASSESSMENT TOOL DEVELOPMENT: CASE 2

EXAMPLES

Team : ______________

Rater: ______________

Date : ______________

SALIANT DERIVED CHECKLIST

FLIGHT SEGMENT	EVENT		BEHAVIOR		CODE	HIT
PRE-FLIGHT	Team member went over pre-flight checklist	1.1	Team member discussed helicopter assignment and location (e.g., "Our helicopter is Comanche" "We will be taking off from Base located at 8 and 9")	P CP	MO 4.1	
		1.2	Team member discussed mission objectives (e.g., "Our mission objective is to follow a pre-planned route until we reach a target area. Once we arrive there we need to destroy the targets")	P CP	MO 4.1	
		1.3	Team member discussed sequence of events (e.g., "We will be flying to several waypoints… at the end of the route we will find target area")	P CP	MO 4.3	
		1.4 1.4A	CP provided name of first waypoint (i.e., Alpha) CP provided info before being asked by P		MO 5.1 MO 5.5	
		1.5 1.5A	CP described location of Alpha (i.e., "Alpha is located at 7.5 and 5:") CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.6 1.6A	CP described heading to fly to Alpha (e.g., "We will be heading North") CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.7 1.7A	CP provided names of other waypoints from "Flying Away From Base" route (e.g., B, D, E, & F) CP provided info before being asked by P		MO 5.1 MO 5.5	
		1.8 1.8A	CP provided location of other waypoints from "Flying Away From Base" route CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.9 1.9A	CP described headings of other waypoints from 'Flying Away from Base" route CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.10 1.10A	CP described the target operations leg (i.e., from D to E, and from E to F). CP provided info before being asked by P		MO 5.1 MO 5.5	
		1.11 1.11A	CP described location of Target area CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.12 1.12A	CP provided names of other waypoints from "Flying Back To Base" route (e.g., G, H, I, Base) CP provided info before being asked by P		MO 5.1 MO 5.5	
		1.13 1.13A	CP provided location of other waypoints from "Flying Back To Base" route CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.14 1.14A	CP described headings of other waypoints from 'Flying Back To Base" route CP provided info before being asked by P		OS 5.1 OS 5.5	
		1.15	Team member suggested to obtain flight duration from AMC	P CP	MO 5.6	
		1.16	Team member discussed fuel level (e.g., "We have enough fuel for mission")	P CP	MO 5.8	
		1.17	Team member suggested to check instruments	P CP	EQ 2.3	
		1.18	CP went over the number of weapons available (e.g., "We have 9 Hellfire, 7 Stinger, 500		EQ 2.2 EQ 5.5	

FLIGHT SEGMENT	EVENT		BEHAVIOR		CODE	MT
		1.18A 1.18B	Cannons") CP provided info before being asked by P _____ Specify weapons			
		1.19	Team member reviewed items from take-off checklist (purple)	P CP	MO 4.1	
		1.20	Team member reviewed items from target destruction checklist (yellow)	P CP	MO 4.1	
		1.21	Team member reviewed items from SAR checklist (green).	P CP	MO 4.1	
		1.22	Team member reviewed items from landing checklist (red).	P CP	MO 4.1	
		1.23 1.23A	CP discussed strategies for calling out when they have arrived at waypoint (e.g., I will describe the area during the middle of the leg, I will let you know as soon as we are over it, I will let you know when the three seconds are up"). CP provided info before being asked by P		MO 4.4 MO 5.5	
TAKE-OFF	Team went over take-off checklist	2.1 2.1A 2.1B	Team member pulled out take off checklist (PURPLE). Team member asked the other to pull out checklist: ________ Specify who asked	P CP	MO 3.1 MO 5.5	
		2.2 2.2A	P requested weather from AMC. P asked for weather before being told by CP		MO 4.1 MO 5.5	
		2.3 2.3A	CP provided wind info for taking off (i.e., maximum speed). CP provided info before being asked by P _____		MO 5.1 MO 5.5	
		2.4 2.4A	CP mentioned reduction in speed over water due to turbulence. CP provided info before being asked by P		MO 4.1 MO 5.5	
		2.5 2.5A	P asked for weather from point Foxtrot. CP provided info before being asked by P		MO 4.1 MO 5.5	
		2.6 2.6A	P reported intentions for take off. P reported intentions before being asked CP		MO 4.1 MO 5.5	
		2.7 2.7A	CP provided heading for point Alpha (i.e., before take off clearance). CP provided info before being asked by P		OS 5.2 OS 5.5	
		2.8 2.8A	P requested take off clearance from AMC. P requested clearance before being asked CP		MO 4.1 MO 5.5	
		2.9 2.9A	CP called out continuously take off info (i.e., rate of climb, airspeed, heading). CP called info before being asked by P		MO 4.1 MO 5.5	
		2.10 2.10A	CP called out final altitude. CP called info before being asked by P		MO 4.1 MO 5.5	
		2.11 2.11A	P confirmed aircraft is airborne and ready for forward flight to AMC. P confirmed info before being asked by CP		MO 4.1 MO 5.5	
		2.12 2.12A	CP logged departure time. CP logged info before being asked by P		MO 4.1 MO 5.5	
LEG FROM BASE TO ALPHA	Team proceeded to point Alpha	3.1 3.1A	CP provided correct heading to point Alpha (i.e., North) –without AMC's assistance. CP provided info before being asked by P_____		OS 1.2 OS 5.5	
		3.2	Team member called out speed reduction before flying over water.	P CP	OS 3.1	
	Charlie 1,3	3.3	Team member verbalized that C 1, 3's call was not for them (i.e., between each other).	P CP	EX 4.2	

FLIGHT SEGMENT	EVENT		BEHAVIOR		CODE	INT
	requested take off clearance					
	AMC requested Charlie 1,4 to report their position	3.4	Team member verbalized that C 1,4's call was not for them (i.e., between each other).	P CP	EX 4.2	
	Team was flying to point Alpha	3.5 3.5A 3.5B	Team member called out salient landmarks in leg (e.g., mountain, river). Specify salient landmarks called out ____ ____ ____ ____ ____ Specify # times salient landmarks were called out:	P CP	OS 1.1	
		3.6 3.6A	CP provided topographical description of Alpha (i.e., before they fly over it, the brown grassy area). CP provided info before being asked by P		OS 5.1 OS 5.5	
		3.7 3.7A	CP provided location of point Alpha (i.e., provided #'s before they fly over it). CP provided info before being asked by P		OS 5.1 OS 5.5	
		3.8 3.8A	CP called out they are approaching point Alpha (i.e., before they fly over it, the grassy area is pt. Alpha). CP provided info before being asked by P		OS 5.1 OS 5.5	
		3.9 3.9A	CP provided heading to point Bravo before approaching point Alpha. (e.g. N,W,L,R). CP provided info before being asked by P		OS 3.1 OS 5.5	
		3.10 3.11	(Please specify which one occurred) ____ P reported to AMC their arrival to point Alpha. ____ P replied to AMC's request for their position.		OS 5.8 OS 4.5	
LEG FROM POINT ALPHA TO BRAVO	Team proceeded to point Bravo	4.1 4.1A	CP provided correct heading to point Bravo –without AMC's assistance. CP provided info before being asked by P____		OS 1.2 OS 5.5	
	Charlie 1,3 lost radio contact with AMC, and attempted to contact the team	4.2	Team member verbalized that C 1,3 lost radio contact.	P CP	EX 2.1	
		4.3 4.3A	P replies to C 1,3. P replied before being asked by the CP		EX 4.5 EX 5.5	
		4.4	Team member suggested that C 1,3 should climb to a higher altitude (i.e., before Charlie 1,3 mentions over the radio that they would climb to a higher altitude).	P CP	EX 2.1	
		4.5 4.5A	P attempted to call C 1,3 to suggest that they climb to a higher altitude. P provided info before being asked by Co-pilot		EX 5.1 EX 5.5	
	Team was flying to point	4.6 4.6A	Team member called out salient landmarks in leg (e.g., mountain, river). Specify salient landmarks called out	P CP	OS 1.1	

Number of behaviors being measured with the SALIANT derived scale

		Generic Behaviors	MO	OS	EX	EQ	PC	TOT
E	1.1	• monitored environment for changes, trends, abnormal conditions (Prince & Edens, 1996)		13				13
E	1.2	• demonstrated awareness of where he/she was (Bunecke et al., 1990)		13				13
P	2.1	• reported problems (Foushee, 1994; Prince & Salas, 1993)		2	2			4
P	2.2	• located potential sources of problem (Prince & Salas, 1993)			2	3		5
P	2.3	• demonstrated knowledge of problem consequences (Prince & Edens, 1996)						0
P	2.4	• resolved discrepancies (Schwartz, 1990)			1			1
P	2.5	• noted deviations (Prince & Salas, 1993)	1					1
A	3.1	• recognized need for action (Prince & Edens, 1996; Foushee, 1994; Prince & Salas, 1993)	17	12	1	1		31
A	3.2	• anticipated consequences of actions and decisions (Prince & Edens, 1996)	1					1
A	3.3	• informed others of actions taken (Leedom, 1990)	5		1			6
A	3.4	• monitored actions (self & others) (Prince & Salas, 1993)						0
T	4.1	• demonstrated knowledge of tasks (Schwartz, 1990)	31					31
T	4.2	• exhibited skilled time sharing attention among tasks (Schwartz, 1990)			3			3
T	4.3	• monitored workload (self & others) (Prince & Edens, 1996)						0
T	4.4	• shared workload within station (Bunecke et al., 1990)	1					1
T	4.5	• answered questions promptly (Prince & Edens, 1996)	1	11	3			15
I	5.1	• communicated important information (Bunecke et al., 1990)	10	40	1			51
I	5.2	• confirmed information when possible (Bunecke et al., 1990; Leedom, 1990)	3	1				4
I	5.3	• challenged information when doubtful (Prince & Salas, 1993; Leedom, 1990; Bunecke et al., 1990)	1					1
I	5.4	• re-checked old information (Mosier & Chidester, 1991)						0
I	5.5	• provided information in advance (Prince & Salas, 1993; Schwartz, 1990)	43	66	5	2		116
I	5.6	• obtained information of what is happening (Foushee, 1994)	1					1
I	5.7	• demonstrated understanding of complex relationships (Bunecke et al., 1990; Schwartz, 1990)						0
I	5.8	• briefed status frequently (Prince & Edens, 1996; Schwartz, 1990)		11				11
		TOTAL	115	169	19	6		309

LEGEND

MO = Mission Objectives
OS = Orientation in Space
EX = External Support
EQ = Equipment Status
PC = Personal Capabilities

E = Demonstrated Awareness of Surrounding Environment
P = Recognized Problem
A = Anticipated Need for Action
T = Demonstrated Knowledge of Tasks
I = Demonstrated Awareness of Information

APPENDIX D - TARGETS PRODUCTS

Crew/Team: ____________ AMC: Yes/No Aircraft Type: ________
Rater: ____________ Date: ________

DERIVED CHECKLIST

FLIGHT SEGMENT	EVENT	BEHAVIOR	HIT	NOTES
BRIEFING	Mission brief to crews	AMC discussed crew and AC assignments		
		AMC requested confirmation from crews		
		PIC or CP confirms crew and AC assignments		
		AMC discussed mission objectives		
		AMC discussed sequence of events, WPs, and risk assessment		
		AMC discussed low fuel, change of AMC, and enemy AC callouts		
		AMC discussed radio frequencies and communications checks		
		AMC discussed weather conditions and effects		
		PIC or CP confirms objectives and sequence of events		
PREFLIGHT	Checklist procedures	PC reviewed sequence of events and mission objectives with CP		
		PIC reviewed items from take-off checklist		
		PIC reviewed items from SAR checklist		

LEGEND: PIC – Pilot-in-command; CP – Copilot; AMC – Air Mission Commander; ✓ - Observed behavior; – - Behavior not observed; / - Task not applicable; PZ – Pick-up Zone; WX – Weather

Crew/Team: ____________ AMC: Yes/No Aircraft Type: __________
Rater: ____________ Date: __________

FLIGHT SEGMENT	EVENT	BEHAVIOR	HIT/	NOTES
		PIC discussed fuel requirements (e.g., "We have sufficient fuel for the mission")		
	WP procedures	-CP provides name and coordinates of each WP -CP provided info before being asked by PIC _____		
		PIC confirmed proper entry of WP info		
		CP discussed strategies for calling out WP arrival		
	Communications check	Lead AC initiates communications check with other AC at the appropriate time prior to take-off		
		Other AC responds to communications check		
TAKE-OFF	Take-off checklist preparation	-Crew member pulled out take-off checklist -Crew member asked other to pull out checklist: ________ Specify who asked		
	Preparation for take-off	-PIC requests weather update from AMC -PIC makes request before being told by PC		
		AMC provides weather info to other AC		
		Lead AC requests take-off clearance		
	Take-off sequence	Lead AC notifies flight of impending take-off (e.g., "Lead pitch pull in 3 seconds")		
		-CP continuously called out take-off info (i.e., rate of climb, airspeed, heading, etc.) -CP provided info before being asked by PIC _____		
		-CP logged departure time -CP logged time before being asked by PIC _____		
		-CP starts clock for fuel check (15 min) -CP starts fuel check before being asked by PIC _____		

Crew/Team: ____________ AMC: Yes/No Aircraft Type: ________

Rater: ____________ Date: ____________

FLIGHT SEGMENT	EVENT	BEHAVIOR	HIT	NOTES
LEG FROM BASE TO WP 1	AC proceeds to WP 1	-Lead AC CP provides correct heading and airspeed guidance to WP 1 -Lead AC CP provides correct heading and airspeed guidance without being prompted by PIC or other AC ____		
		Other AC confirms heading and airspeed guidance		
		-Lead AC CP provides topographical description of WP 1 before flying over it -Lead AC CP provides topographical description of WP1 before being prompted by PIC ____		
		-Lead AC reported to AMC their arrival at WP 1 -Lead AC replied to AMC's request for position ____		
LEG FROM WP 1 TO WP 2	AC proceeds to WP 2	-Lead AC CP provides heading to WP 2 -Lead AC CP provided heading without being prompted by PIC ____		
		Other AC confirms heading and airspeed guidance		
	Change of light lead	AMC announces change of lead AC: ________ Specify what AC is now lead		
		-Other AC acknowledge lead change -Other AC acknowledge lead change without being asked by AMC ____		
		New lead AC announces lead position (e.g., "ROCKER 26 in front")		
		-Lead CP provides current heading info to WP 2 -Lead CP provides current heading info without being asked by other AC ____		
		-Lead AC CP provides topographical description of WP 2 before flying over it -Lead AC CP provides topographical description of WP 2 before being prompted by PIC ____		

Crew/Team: ____________ AMC: Yes/No Aircraft Type: ____________
Rater: ____________ Date: ____________

FLIGHT SEGMENT	EVENT	BEHAVIOR	HIT	NOTES
		-Lead AC reported to AMC their arrival at WP 2 -Lead AC replied to AMC's request for position _____		
LEG FROM WP 2 TO PZ	AC proceeds to PZ	-Lead AC CP provides correct heading and airspeed guidance to PZ -Lead AC CP provides correct heading and airspeed guidance without being prompted by PIC or other AC ____		
		Other AC confirms heading and airspeed guidance		
		-Lead AC CP provides topographical description of PZ before landing -Lead AC CP provides topographical description of PZ before being prompted by PIC _____		
	Sequence of troop extraction	-Lead AC reported to AMC their arrival at PZ -Lead AC replied to AMC's request for position _____		
		AC reports pick-up of troops to the AMC		
		Lead AC notifies flight of impending departure (e.g., "Lead pitch pull in 3 seconds")		
LEG FROM PZ TO WP 3	AC proceeds to WP 3	-Lead AC CP provides correct heading and airspeed guidance to WP 3 -Lead AC CP provides correct heading and airspeed guidance without being prompted by PIC or other AC ____		
		Other AC confirms heading and airspeed guidance		
	AMC requests position report from AC ___	AMC requests position report from AC ___		
	AC ___ experiences lost radio contact with the AMC	PIC or CP of AC ___ makes repeated attempt to call AMC		
		PIC or CP of AC ___ announces to flight that communications have been lost with the AMC		

Crew/Team: ____________ AMC: Yes/No Aircraft Type: ________
Rater: ____________ Date: ____________

FLIGHT SEGMENT	EVENT	BEHAVIOR	HIT	NOTES
		PIC or CP of other AC suggests that AC ___climb to a higher altitude		
		PIC or CP of AC ___ suggests climbing to higher altitude (before hearing suggestion from AC above)		
		PIC or CP of AC ___ announces temporarily departing flight for a higher altitude		
		Other AC acknowledge departure		
	Communications with AMC restored	PIC or CP of AC ___ makes repeated attempt to call AMC		
		AMC acknowledges transmissions		
		PIC or CP of AC ___ announces return to flight		
		Other AC acknowledge return		
		-Lead AC CP provides topographical description of WP 3 before flying over it -Lead AC CP provides topographical description of WP 3 before being prompted by PIC ___		
		-Lead AC reported to AMC their arrival at WP 3 -Lead AC replied to AMC's request for position _____		
LEG FROM WP 3 TO BASE	AC proceeds to Base	-Lead AC CP provides correct heading and airspeed guidance to Base -Lead AC CP provides correct heading and airspeed guidance without being prompted by PIC or other AC ___		
		Other AC confirms heading and airspeed guidance		
	Landing procedures	-Lead AC calls for WX and clearance -Lead AC calls for info without being asked by AMC ___		

Crew/Team: ____________________ AMC: Yes/No Aircraft Type: ____________

Rater: ____________________ Date: ____________________

FLIGHT SEGMENT	EVENT	BEHAVIOR	HIT	NOTES
		-Crew member pulled out landing checklist -Crew member asked other to pull out checklist: ________ Specify who asked		
		Lead AC announces intention to land		
		Other AC acknowledge intention		
		-CP continuously called out landing info (i.e., rate of descent, airspeed, heading) -CP called out info before being prompted by PIC _____		
		-PIC confirmed landing to AMC -PIC confirmed safe landing before being prompted by AMC _____		
		-CP logged arrival time -CP logged time before being prompted by PIC _____		

ROTARY WING MULTI-SHIP SCENARIO (UTILITY)

The following scenario is designed for use in a PC-based, low-cost simulation environment. It assumes the participation of a flight of three or more U.S. Army utility helicopters and represents the conduct of a generic troop extraction mission.

MISSION BRIEF

All crews will participate in a mission brief at the base station prior to "flying" the mission. The AMC will be charged with heading the brief. Items to be briefed include, but are not limited to, crew and aircraft assignments, weather, mission objectives, waypoints, PZ, and lost communication procedures.

PREFLIGHT/TAKE-OFF

Crews will report to their designated aircraft and proceed with the appropriate checklist and communications procedures. Following proper clearance from ATC (simulated by the evaluator), the flight will depart the base station in accordance with the appropriate checklist and take-off procedures.

MISSION

The flight will be required to proceed to a series of waypoints enroute to a predetermined PZ for troop pickup. After landing at the PZ and executing the troop extraction, the flight will return to the base station via an alternate set of waypoints. During the mission, crews may encounter unexpected events such as change of flight lead, lost communications, or change of mission.

DEBRIEF

Following completion of the mission, crews will be briefed on their collective performance and conduct of the mission.

APPENDIX E - SME SURVEY

SUBJECT MATTER EXPERT (SME) SURVEY SHEET

SME Name: ______________________ Date: ____________

Rank/Position: ____________________

Please answer the following questions as they apply to the attached scenario and TARGETs checklists. Annotate suggested changes, additions, and deletions in the blanks provided and/or on the actual documents. If additional comments are needed, place them on a sheet of paper and attach it to this survey.

1) Does the given scenario accurately incorporate essential tasks that might be expected during U.S. Army multi-ship, utility helicopter operations? YES/NO
If not, please annotate.

____

____

____

2) Are the given EVENTS listed in the TARGETs checklists implicit to the above mission and appropriately sequenced for a multi-ship, helicopter mission? YES/NO
Are there any missing or worthy of deletion?

____

____

____

3) Are the BEHAVIORS listed in the TARGETs checklists tasks that crews would be expected to perform during a multi-ship, helicopter mission? YES/NO

____

____

____

4) Could wording be improved anywhere on the TARGETs checklist in order to improve its quality? YES/ NO
If so, please note changes directly on the checklist.

APPENDIX F - SME RESULTS

SUBJECT MATTER EXPERT (SME) SURVEY SHEET

SME Name: J.P. Carruthers Date: 6-8-00

Rank/Position: CW3 / Instructor Pilot

Please answer the following questions as they apply to the attached scenario and TARGETs checklists. Annotate suggested changes, additions, and deletions in the blanks provided and/or on the actual documents. If additional comments are needed, place them on a sheet of paper and attach it to this survey.

1) Does the given scenario accurately incorporate essential tasks that might be expected during U.S. Army multi-ship, utility helicopter operations? YES/NO
If not, please annotate.

~~But~~ -

2) Are the given EVENTS listed in the TARGETs checklists implicit to the above mission and appropriately sequenced for a multi-ship, helicopter mission? YES/NO
Are there any missing or worthy of deletion?

3) Are the BEHAVIORS listed in the TARGETs checklists tasks that crews would be expected to perform during a multi-ship, helicopter mission? YES/NO

But - the CP is the only ~~only~~ one that gets evaluated or at least its his behavior that evident 80% of the time. If its multi-ship when does the other crews (PF and PNF) get evaluated?

4) Could wording be improved anywhere on the TARGETs checklist in order to improve its quality? YES/ NO
If so, please note changes directly on the checklist.

For the purpose of this study PIC should be designated as the flying pilot. The scenario indicates its the CP and AMC that is being observed when there are two crewmembers up front.

SUBJECT MATTER EXPERT (SME) SURVEY SHEET

SME Name: RAY CECH Date: 8 JUN 00

Rank/Position: GS-13 DAC SP/IE

Please answer the following questions as they apply to the attached scenario and TARGETs checklists. Annotate suggested changes, additions, and deletions in the blanks provided and/or on the actual documents. If additional comments are needed, place them on a sheet of paper and attach it to this survey.

1) Does the given scenario accurately incorporate essential tasks that might be expected during U.S. Army multi-ship, utility helicopter operations? YES/NO
If not, please annotate.

2) Are the given EVENTS listed in the TARGETs checklists implicit to the above mission and appropriately sequenced for a multi-ship, helicopter mission? YES/NO
Are there any missing or worthy of deletion?

ONLY THING THAT MIGHT BE ADDED IS PLANS FOR AIRCRAFT EMERGENCIES THAT COULD BE ENCOUNTERED, IE ENGINE FAILURES LOSS OF HYDRAULIC SYSTEMS, ETC. PC COULD BRIEF ACTIONS TO BE TAKEN, CREW DUTIES, ETC. THIS COULD BE ADDED TO PREFLT SECTION OF CHECKLIST.

3) Are the BEHAVIORS listed in the TARGETs checklists tasks that crews would be expected to perform during a multi-ship, helicopter mission? YES/NO

NOTED CREW COORDINATION CONCEPTS INCORPORATED INTO SCENARIO - THAT IS GOOD.

4) Could wording be improved anywhere on the TARGETs checklist in order to improve its quality? YES/NO SHORT, CONCISE, WORDING SEEMS TO BE INCORPORATED.
If so, please note changes directly on the checklist.

SUBJECT MATTER EXPERT (SME) SURVEY SHEET

SME Name: _Mike Dolezal___________ Date: _6/14/00_____

Rank/Position: _LtCol USMC (retired)__

Please answer the following questions as they apply to the attached scenario and TARGETs checklists. Annotate suggested changes, additions, and deletions in the blanks provided and/or on the actual documents. If additional comments are needed, place them on a sheet of paper and attach it to this survey.

1) Does the given scenario accurately incorporate essential tasks that might be expected during U.S. Army multi-ship, utility helicopter operations?[redacted]/NO
If not, please annotate.
Assuming this is a tactical mission, you may want to address the enemy situation, possible threats, support resources available, and other related items.

____

2) Are the given EVENTS listed in the TARGETs checklists implicit to the above mission and appropriately sequenced for a multi-ship, helicopter mission?[redacted]/NO
Are there any missing or worthy of deletion? The EVENTS are realistic for a routine mission. You may consider adding some items to make an 'other than routine' mission and observe the effect on situational awareness.____

3) Are the BEHAVIORS listed in the TARGETs checklists tasks that crews would be expected to perform during a multi-ship, helicopter mission?[redacted]/NO
The CP BEHAVIORS generally describe or separate the seasoned, think-ahead 'sierra hotel' CP from the novice and average CPs.

____

____

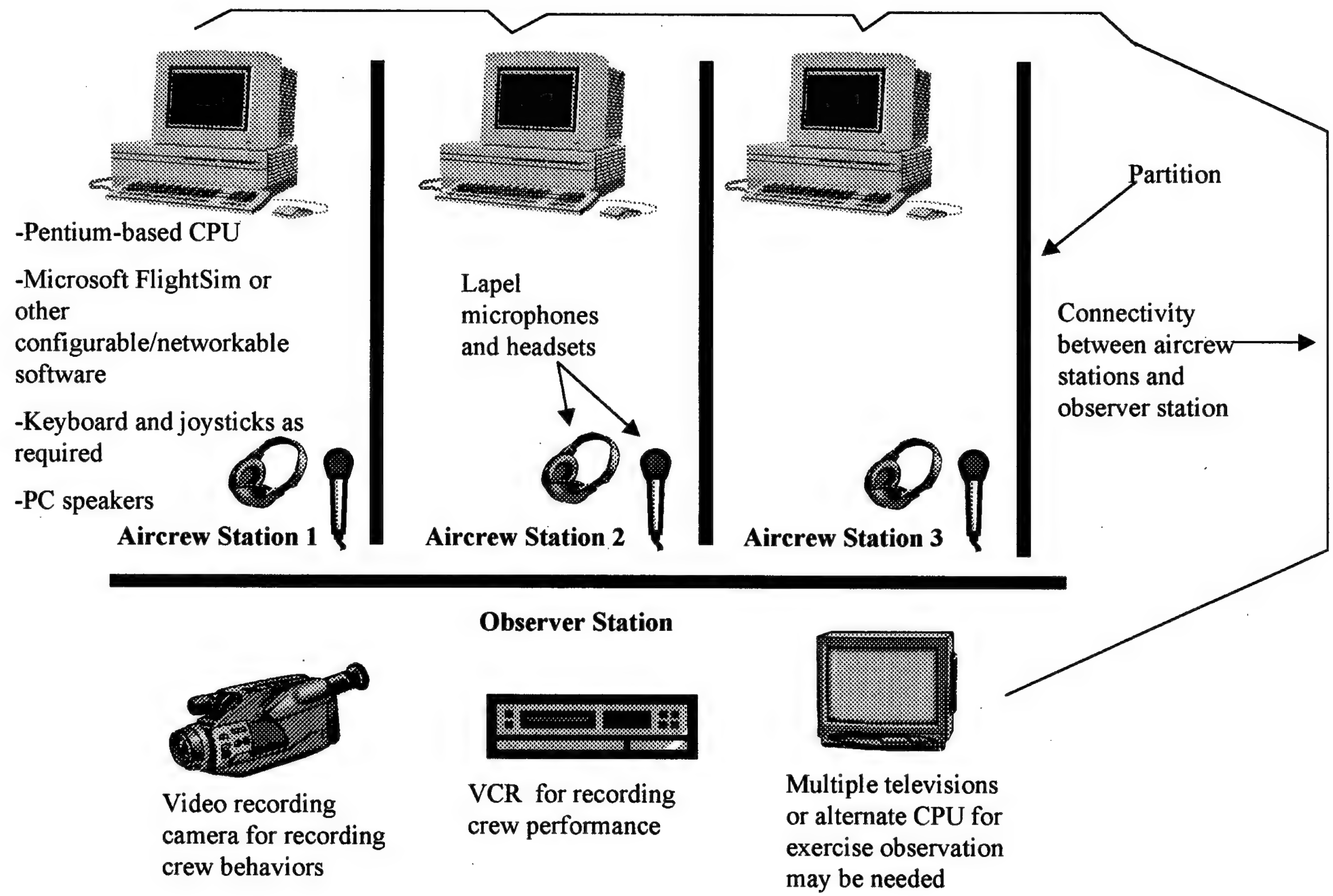
4) Could wording be improved anywhere on the TARGETs checklist in order to improve its quality? YES/[redacted]
If so, please note changes directly on the checklist.

APPENDIX G - MASTER CHECKSHEET AND DEPICTION FOR CONCEPTUAL MODEL CASE COMPARISON

Conceptual Model Cross Comparison Checksheet

Case	Team Training/SA?	PC System	Software	Controls
(1) Individual Task Proficiency and Team Process Behavior	Team Training	286 IBM compatible	MicroProse *Gunship*	-Keyboard -Joystick
(2) Communication and Team Situation Awareness	-Team Training -SA	386/33 MHz IBM compatible	*Flight Simulator 4.0*	-Keyboard -Optional joystick

Case	Monitors	Video Equipment	Audio Equipment	Other
(1) Individual Task Proficiency and Team Process Behavior	3 Total -1 per crew member -1 for review & performance assessment	-Portable camera -Video tape recorder -Black-and-white TV set	-Radio Shack® lapel microphones -Radio Shack® headphone sets -PC speakers	Partitions
(2) Communication and Team Situation Awareness	1 VGA monitor for instruments & scenes	Video tape recorder	PC speakers	



PC-Based Conceptual Model Depiction

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